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AIR AND RADIATION

**MEMORANDUM**

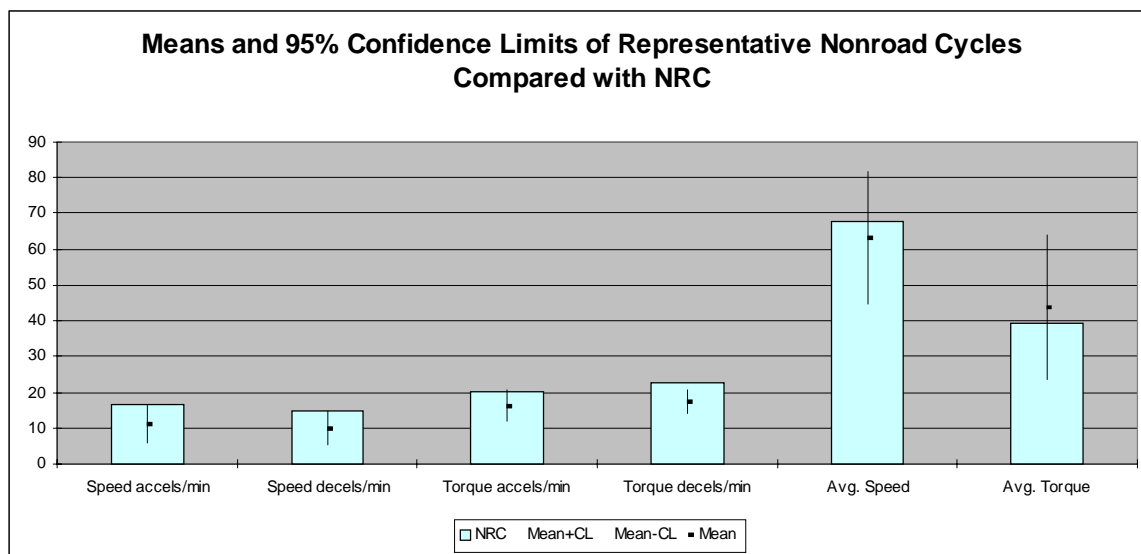
SUBJECT: EPA / Dyntel Duty Cycle Analysis Report

TO: EPA Air Docket A-2001-28

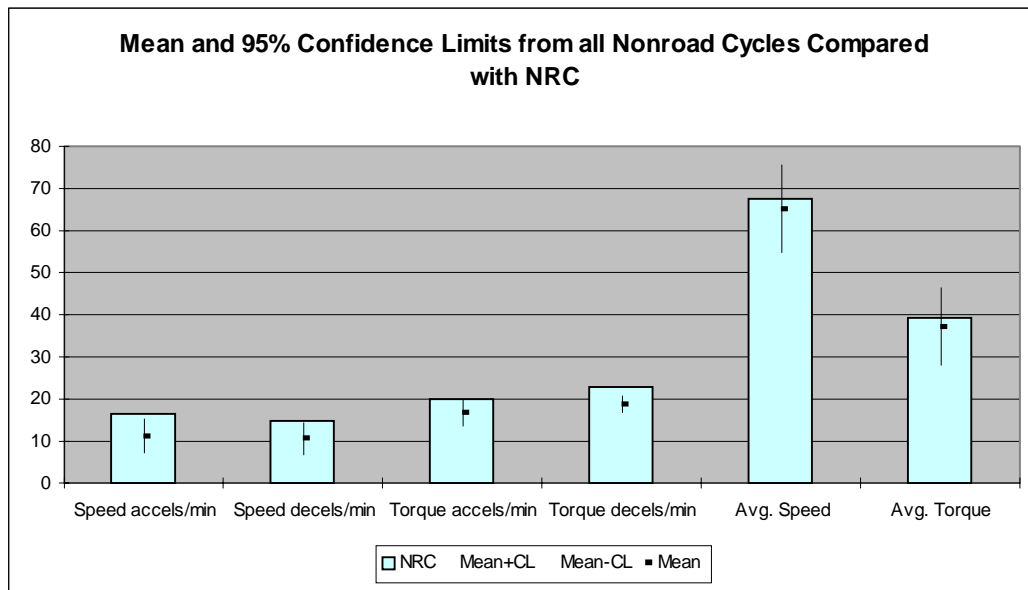
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DATE: April 24, 2003

The attached report details the analysis of the cycle characteristics used for generation of a composite nonroad transient cycle and for comparison with the activity of related and component nonroad and other duty cycles. The report describes in detail the “big” bin and “small” bin analyses. The terms big or small simply refer to the scale of the analysis. The analyses are meant to describe the transient nature of the duty cycles. Analysis of the Nonroad Transient Duty Cycle indicates that statistically, it is similar to the component duty cycles from it was compiled. Please see figures 1 and 2 below.



**Figure 1. NRTC Comparison to Component (Representative) Cycles**



**Figure 2. NRTC Comparison to Full Set of Nonroad Duty Cycles**

The analyses were conducted for each cycle as shown in the table below.

Lotus Charts	Appendix <sup>1</sup>
Backhoe	C.1 and C.2
Crawler	D.1 and D.2
Agricultural Tractor	E.1 and E.2
Welder Typical 1	F.1
Welder Typical 2	G.1 and G.2
Welder High Speed Transient	H.1
Welder High Torque Transient	I.1 and I.2
Wheel Loader Typical 1	J.1 and J.2
Wheel Loader Typical 2	K.1
Wheel Loader High Speed Transient	L.1
Wheel Loader High Torque Transient	M.1 and M.2
Skid Steer Loader Typical 1	N.1 and N.2

**Table 1. Cycles Analyzed**

<sup>1</sup>Backhoe small bin analysis is in Appendix C.1 and backhoe big bin analysis is in Appendix C.2. Similarly, all small bin analyses in the Appendices are found in Appendix -.1; and all big bin charts are found in Appendix-.2.

The characteristics of the cycles that were subject to bin regime analysis included:

- Counts within a given operating regime
- Speed accelerations
- Speed decelerations
- Speed steady stats
- Torque accelerations
- Torque decelerations
- Torque steady states

This memorandum represents summary of the initial review of the characteristics of the composite nonroad transient duty cycle and its similarity to the broader set of duty cycles generated based on real world operation.

**Bin Analysis of Nonroad Transient Cycles**

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March 25, 2003



## Table of Contents

<b>I.</b>	<b>Abstract</b>	1
<b>II.</b>	<b>The Data</b>	1
<b>III.</b>	<b>SAS Programs</b>	1
	A.1 <i>Small Bin Analysis</i>	1
	A.2 <i>Big Bin Analysis</i>	2
<b>IV.</b>	<b>Chart Production</b>	3
<b>V.</b>	<b>Results</b>	4
	A.1 <i>Backhoe Small Bin</i>	4
	A.2 <i>Backhoe Big Bin</i>	6
	B.1 <i>Crawler Small Bin</i>	7
	B.2 <i>Crawler Big Bin</i>	8
	C.1 <i>Agricultural Tractor Small Bin</i>	9
	C.2 <i>Agricultural Tractor Big Bin</i>	10
	D.1 <i>Welder–Typical 1 Small Bin</i>	11
	E.1 <i>Welder–Typical 2 Small Bin</i>	12
	E.2 <i>Welder–Typical 2 Big Bin</i>	14
	F.1 <i>Welder–High Speed Transient Small Bin</i>	14
	G.1 <i>Welder–High Torque Transient Small Bin</i>	15
	G.2 <i>Welder–High Torque Transient Big Bin</i>	17
	H.1 <i>Wheel Loader–Typical 1</i>	17
	H.2 <i>Wheel Loader–Typical 1 Big Bin</i>	19
	I.1 <i>Wheel Loader–Typical 2 Small Bin</i>	19
	J.1 <i>Wheel Loader–High Speed Transient Small Bin</i>	20
	K.1 <i>Wheel Loader–High Torque Transient Small Bin</i>	22
	K.2 <i>Wheel Loader–High Torque Transient Big Bin</i>	24
	L.1 <i>Skid Steer Loader–Typical 1 Small Bin</i>	24
	L.2 <i>Skid Steer Loader–Typical 1 Big Bin</i>	26
	M.1 <i>Skid Steer Loader–Typical 2 Small Bin</i>	26
	N.1 <i>Skid Steer Loader–High Speed Transient Small Bin</i>	27
	O.1 <i>Skid Steer Loader–High Torque Transient Small Bin</i>	29
	O.2 <i>Skid Steer Loader–High Torque Transient Big Bin</i>	31
	P.2 <i>Excavator Big Bin</i>	31
	Q.1 <i>Nonroad Transient Small Bin</i>	31
	Q.2 <i>Nonroad Transient Big Bin</i>	33
	R.1 <i>FTP DCS4 Small Bin</i>	33
	R.2 <i>FTP DCS4 Big Bin</i>	35
<b>VI.</b>	<b>Cycle Comparisons</b>	36
	A. <i>NRC Comparison with 7 Representative Nonroad Cycles</i>	36
	B. <i>NRC Comparison with 10 Typical and High Torque Nonroad Cycles</i>	36
	C. <i>NRC Comparison with all 16 Nonroad Cycles</i>	37
<b>VII.</b>	<b>References</b>	37

<b>VIII.</b>	<b>Appendices</b>	38
A.1	<i>Small bin SAS Programs--Example using Backhoe</i>	38
A.2	<i>Big bin SAS Programs--Example using Backhoe</i>	46
B.1	<i>Lotus Small Bin Spreadsheet Example--Backhoe Overall Counts</i>	48
B.2	<i>Lotus Big bin Spreadsheet Example--Backhoe Overall Counts</i>	49
C.1	<i>Backhoe Small Bin Charts</i>	50
C.2	<i>Backhoe Big Bin Charts</i>	50
D.1	<i>Crawler Small Bin Charts</i>	53
D.2	<i>Crawler Big Bin Charts</i>	53
E.1	<i>Agricultural Tractor Small Bin Charts</i>	56
E.2	<i>Agricultural Tractor Big Bin Charts</i>	56
F.1	<i>Welder--Typical 1 Small Bin Charts</i>	59
G.1	<i>Welder--Typical 2 Small Bin Charts</i>	59
G.2	<i>Welder--Typical 2 Big Bin Charts</i>	59
H.1	<i>Welder--High Speed Transient Small Bin Charts</i>	62
I.1	<i>Welder--High Torque Transient Small Bin Charts</i>	62
I.2	<i>Welder--High Torque Transient Big Bin Charts</i>	62
J.1	<i>Wheel Loader--Typical 1 Small Bin Charts</i>	65
J.2	<i>Wheel Loader--Typical 1 Big Bin Charts</i>	65
K.1	<i>Wheel Loader--Typical 2 Small Bin Charts</i>	68
L.1	<i>Wheel Loader--High Speed Transient Small Bin Charts</i>	68
M.1	<i>Wheel Loader--High Torque Transient Small Bin Charts</i>	68
M.2	<i>Wheel Loader--High Torque Transient Big Bin Charts</i>	68
N.1	<i>Skid Steer Loader--Typical 1 Small Bin Charts</i>	71
N.2	<i>Skid Steer Loader--Typical 1 Big Bin Charts</i>	71
O.1	<i>Skid Steer Loader--Typical 2 Small Bin Charts</i>	74
P.1	<i>Skid Steer Loader--High Speed Transient Small Bin Charts</i>	74
Q.1	<i>Skid Steer Loader--High Torque Transient Small Bin Charts</i>	74
Q.2	<i>Skid Steer Loader--High Torque Transient Big Bin Charts</i>	74
R.2	<i>Excavator Big Bin Charts</i>	77
S.1	<i>Nonroad Transient Small Bin Charts</i>	80
S.2	<i>Nonroad Transient Big Bin Charts</i>	80
T.1	<i>FTP DCS4 Small Bin Charts</i>	83
T.2	<i>FTP DCS4 Big Bin Charts</i>	83
U.1	<i>NRC Comparisons with 7 Typical Nonroad Cycles</i>	86
U.2	<i>NRC Comparisons with 10 Typical and High Torque Cycles</i>	87
U.3	<i>NRC Comparisons with all 16 Nonroad Cycles</i>	89

## Bin Analysis of Nonroad Transient Cycles

### I. Abstract

Nonroad transient cycles, including agricultural tractor, backhoe, and crawler representative duty cycles, are analyzed using data gathered by Southwest Research Institute and provided by EPA. Four activity patterns for Welder, Wheel Loader, and Skid Steer Loader are prepared, namely patterns called Typical 1, Typical 2, High Speed Transient, and High Torque Transient. Finally, a composite cycle, the Nonroad Transient Cycle (NRC), is also analyzed and compared with other cycles. In addition the transient Federal Test Procedure (FTP) DCS4 data are analyzed and available for comparison with the nonroad cycle.

In all cases, the SAS statistical package prepares the data for Lotus spreadsheet entry. Using Lotus charting procedures applied to the data for each duty cycle, three dimensional charts are produced, corresponding to a small bin or a big bin analysis. A small bin analysis presents information over relatively small ranges of speed and torque; a big bin analysis presents averages over broad ranges of speed and torque.

In small bin analyses, separate charts are prepared for acceleration, deceleration, and steady state speeds and torque for counts, sums, means and standard deviations as a function of torque (%) and speed (%). In addition for each cycle, charts are created for overall counts, mean torque changes with time, and mean speed changes with time.

Big bin analysis includes charts and descriptions of speed and torque acceleration counts, average speed or torque changes with time for speed accelerations, and average speed or torque changes with time for torque decelerations.

NRC is compared to three sets of the nonroad cycles based on the averages for speed and torque, and the numbers per minute of speed and torque accelerations and speed and torque decelerations for three sets of cycles, namely typical cycles, typical and high torque cycles, and all nonroad cycles.

### II. The Data

The data for each cycle give second-by-second torque and speed values. Additional information on these data, supplied by EPA, are published<sup>[1,2,3,4]</sup>.

### III. SAS Programs

#### A.1 *Small Bin Analysis*

Appendix A.1 presents the SAS programs to produce a small bin analysis for backhoe (electronic copies are also available of these programs). Simple modifications to these backhoe programs are used in the small bin analyses of crawler, agricultural tractor, FTP DCS4 data<sup>1</sup>, and other transient duty cycles. The first program, ba1.sas, produces files containing overall counts, overall mean speed accelerations, and overall mean torque accelerations, all as a function of speed and torque. The program is organized into three sections, one for each of the three cases mentioned. First SAS macro variables are set using %let, and then applied to the include file comp.sas, whose listing follows ba1.sas. The variable tpe indicates the type of statistical operation--n for obtaining counts or mean for finding an average. The variable vars is set to cnt (counts), dsp (change in speed in one second, or speed acceleration), and dtor (change in torque in one second, or torque acceleration).

The include file, comp.sas, following the ba1.sas listing, begins with the entry of the backhoe data, which gives speed and torque values at 1 second intervals. A variable, named cnt, keeps track of the number of each observation. Change in speed (dsp) and change in torque (dtor) are computed. Now dsp and dtor are accelerations because they are changes in speed or torque per second. Also, for

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<sup>1</sup>See 40 CFR Part 86.

backhoe, crawler, and agricultural tractor, the speed and torque values in the data are placed in 1 of 21 intervals from -5 to 0, >0 to 5, ..., >95 to 100. FTP DCS4 data have different ranges of speeds and torque: speeds from -5 to 0, ..., >100 to 105, >105 to 115<sup>2</sup>; torque from >-55 to -50, >-50 to -45, ..., >95 to 100. Similarly, other cycles can have speed and torque intervals below 0 and above 100.

In Lotus the interval definitions are used to create the x-y axes of the charts; the z-axis is computed in the next SAS step, proc summary. In this step, the macro variable indicates the kind of analysis to be preformed, whether simple counts or means are going to be computed, for the variables listed in the "var &vars;" statement. The next few steps fill the matrix of data values with 0's, for any torque interval-speed interval (which is abbreviated as a "torque, speed interval") that has no corresponding data. For example, if the interval >5 to 10% torque (tor=2) and the interval >0 to 5% speed (sp=1), written below as >0-5% torque, >0-5% speed, has no observation, i.e., if no observation of the original backhoe file has both torque and speed in the designated intervals, then by convention 0 is assigned to tor=2 and sp=1. Proc transpose converts the flat file to a matrix of torque columns and speed rows. If, indeed, 0 were assigned to tor=2 and sp=1, then this 0 would be placed in the second row and the third column, when tpe=n. In other words for counts data, 0 counts were found in the backhoe data of observations having speed and torque in the interval >5-10% torque, >0-5% speed. Finally, the matrix is printed in a form that can be entered into Lotus, after manual editing.

In the next SAS program, ba2.sas, backhoe data are input and then split into three files: one file contains speed accelerations (defined as dsp greater than or equal to 2); another decelerations (dsp less than or equal to -2); and the third file contains steady state data (dsp less than 2 and greater than -2). Then ba2.sas divides the data into accelerations, decelerations, and steady state, analyzing the distribution of counts, sums, means, and standard deviations for change-in-speed data. Each analysis uses macro variables followed by an include code portion, which uses the specified macro variables. For example, in ba2.sas after the first data step, a series of 6 consecutive lines identify this as acceleration data (in the title2 statement); performing a counts analysis (in the title3 statement); where tpe is set to n, which indicates counts; vars is set to cnt; dspeed is acc, specifying acceleration data internally to the program; and comp2.sas is the include file, which runs after these values had been set. In the next set of 4 lines of instructions, title2 and dspeed are not changed, so they remain in effect for the second run of comp2.sas, this time for speed data that will be summed. The major difference between comp2.sas and comp.sas, which has been previously discussed, is that data inputs are not included; the data inputs occur in ba2.sas.

A parallel procedure is used in bat2.sas to analyze torque accelerations, steady states, and decelerations. The major change is in the vars macro variable. Instead of dsp, indicating change in speed, vars becomes dtor, change in torque. The include file is similar to comp2.sas, only now named compt2.sas.

For all cases, the output of these SAS programs is labeled tables of numbers. The DOS editor is used to separate the tables, remove extraneous labeling, and leave only the numbers. Each table is put in its own individual text file, identified by name, and then entered into Lotus.

## A.2 *Big Bin Analysis*

A big bin analysis has larger categories of speed and torque than for the small bin analysis. If speed and torque are both less than 10 percent, the backhoe is at idle. Speeds less than 40 are low, from 40 to <60 are medium, from 60 to <75 are intermediate, and greater than or equal to 75 are classified as high. The same ranges are used to categorize torque as either low, medium, intermediate, or high. Appendix A.2 presents a file, compare.sas, which output three tables for speed and three for torque.

The input data are grouped into the big bins, and classified as idle, low, intermediate, and high observations. The data are then separated into files that contain either accelerations (dsp greater than or

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<sup>2</sup>The FTP DCS4 intervals with speeds 105 to 115 for all torque are bigger than any other interval for agricultural tractor, backhoe, crawler and the other cycles because of an apparent limitation in Lotus. When the speed intervals were chosen as -5 to 0, ..., >100 to 105, >110 to 115, the -5 to 0 speed intervals were not drawn on the chart. Welder, wheel loader, and skid steer loader charts were produced by a later version of Lotus (1-2-3 97 Editions), and did not have this limitation.

equal to 2), decelerations (dsp less than or equal to -2), or steady state data, first for speed then for torque. The speed accelerations are placed in tables (proc tabulate in SAS), showing the number of observations for each big bin, namely the number of observations at idle, the number having low values of speed and low values of torque, the number having low values of torque with medium values of speed, and so forth for each combination of low, medium intermediate and high for speed and of low, medium intermediate and high for torque, along with at idle. For speed acceleration, the first table presents counts for each big bin combination of speed and torque and the other present the mean speed or the mean torque for each big bin combination. Finally, three similar tables are produce for torque accelerations (dtor greater than or equal to 2).

#### IV. Chart Production

Appendix B.1 gives the backhoe small bin spreadsheet for overall counts; an electronic copy of the spreadsheet, backn.wk4, is available. The corresponding big bin chart for backhoe is found in Appendix B.2; an electronic copy of the spreadsheet, csa.wk4, is also available.

In the small bin analysis, the Lotus spreadsheet file name is the same as the corresponding text file name processed from the SAS output. The name is coded: for example, back indicates backhoe, n means counts, and having a "t" in the name indicates torque data. The big bin analysis is also coded—for example, the csa in csa.wk4 indicates Counts of Speed Accelerations.

Charts are prepared for the cycles of backhoe, crawler, agricultural tractor, FTP DCS4, and Nonroad Transient Cycle (NRC) and for Welder Typical 1, Welder Typical 2, Welder High Speed Transient, Welder High Torque Transient, Wheel Loader Typical 1, Wheel Loader Typical 2, Wheel Loader High Speed Transient, Wheel Loader High Torque Transient, Skid Steer Loader Typical 1, Skid Steer Loader Typical 2, Skid Steer Loader High Speed Transient, and Welder High Torque Transient. For each cycle, separate charts were prepared for speed and torque; acceleration, deceleration, and steady state for each of four statistics--counts, sums, means, and standard deviations. Besides these charts, each cycle has 3 additional overall charts for counts, and speed and torque acceleration changes. Acceleration for the overall charts has both positive and negative changes in speed per time. The following table indicates the Appendices in which the Lotus charts can be found:

Lotus Charts	Appendix <sup>3</sup>
Backhoe	C.1 and C.2
Crawler	D.1 and D.2
Agricultural Tractor	E.1 and E.2
Welder Typical 1	F.1
Welder Typical 2	G.1 and G.2
Welder High Speed Transient	H.1
Welder High Torque Transient	I.1 and I.2
Wheel Loader Typical 1	J.1 and J.2
Wheel Loader Typical 2	K.1
Wheel Loader High Speed Transient	L.1
Wheel Loader High Torque Transient	M.1 and M.2

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<sup>3</sup>Backhoe small bin analysis is in Appendix C.1 and backhoe big bin analysis is in Appendix C.2. Similarly, all small bin analyses in the Appendices are found in Appendix -.1; and all big bin charts are found in Appendix-.2.

Skid Steer Loader Typical 1	N.1 and N.2
Skid Steer Loader Typical 2	O.1
Skid Steer Loader High Speed Transient	P.1
Skid Steer Loader High Torque Transient	Q.1 and Q.2
Excavator	R.2
Nonroad Transient	S.1 and S.2
FTP DCS4	T.1 and T.2

For big bin analysis each table output from SAS is then transcribed into a Lotus worksheet, with column headings idle, low, medium, intermediate and high torque and row entries high speed, intermediate, medium, low speed, and idle. The tables output from SAS are used to fill in each cell on six worksheets, each worksheet corresponding to a single table. Finally, a chart is produced from the speed and torque data. Appendix B.2 gives the spreadsheet for overall counts. The big bin analysis, when present, follows the small bin analysis in the Appendix.

Finally, a comparative analysis is produced, using Excel spreadsheets to produce charts (see Appendix U). Three different sets of charts are produced to compute NRC average values with:

1. The averages of seven typical nonroad cycles,
2. The average of 10 typical and high torque cycles, and
3. The average of all 16 nonroad cycles.

Each set of charts represents the averages for NRC and for each nonroad cycle in the groups listed above:

- Speed and torque,
- Number of speed accelerations per minute and number of torque accelerations per minute, and
- Number of speed decelerations per minute and number of torque decelerations per minute.

Once the averages for each cycle are computed, the overall averages (the average of the cycle averages) and the 95 percent confidence intervals are computed from the averages in 1., 2., and 3. above for speed, torque, speed/torque accelerations per minute, and speed/torque decelerations per minute. Three summary Excel charts are included in the **Results**.

## V. Results

Based on the Lotus outputs (Appendices C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, and T) with details supplied by the SAS output tables, the results of the analyses are presented for each cycle. The overall data for each cycle are presented for overall counts, speed accelerations/decelerations, and torque accelerations/decelerations. Then the data are split into three parts:

- Accelerations, speed or torque changes in consecutive seconds of greater than or equal to 2.
- Decelerations--speed or torque changes in consecutive seconds of less than or equal to -2.
- Steady State--speed or torque changes in consecutive seconds greater than -2 and less than 2.

For each part, and separately for speed and torque changes, the small bin analysis prepares four detailed descriptions based on the four Lotus charts for counts, sums, means, and standard deviations. The large-bin analysis produces six Lotus charts, each of which are described in the detailed description below. The comparative analysis produces three Excel charts, included below with a discussion, and nine additional charts in Appendix U.

### A.1 Backhoe Small Bin

1. OVERALL--The three overall plots are presented. The largest counts of observations are at 0-10% torque, 0-5% speed. A total of 163 counts are found at these at-idle locations. Lower counts are found at 20-60% torque, 85- 95% speed.

Mean speed changes with time show a pattern of negative changes for torque less than 35% and speeds less than 20%. Generally positive changes per second are at torque higher than 25% torque with speeds ranging from about 20% to 75%, although both positive and negative mean speed changes occur in this region. The largest mean speed change with time is 64 at 95-100% torque, 65-70% speed; the largest, in magnitude, negative mean change is -49 at -5-0% torque, 10-15% speed.

Positive mean torque changes with time tend to occur for torque greater than 50%; negative mean torque changes occur for torque less than 50% throughout the range of speeds. The largest positive torque change, 93, occurs in two intervals, at 90-95% torque, 5-10% speed and at 90-95% torque, 30-35% speed. The largest negative torque change with time, -85, occurs at 10-15% torque, 90-95% speed.

2. SPEED ACCELERATIONS--Few counts are recorded in the backhoe data. These counts are generally spread throughout the torque-speed plane, except for a slight concentration at 20-50% torque and both 55-70% and 85-95% speed. More counts are at 40-45% torque, 25-40% speed. The largest count of 4 is at 35-40% torque, 60-65% speed.

The acceleration sums reflect the counts distribution, in that they also tend to be spread throughout the speed-torque plane with the largest sum, 78, at 30-35% torque, 55-60% speed. Other regions of large sums are 40-70% torque, 20-40% speed and at two more torque regions, 80-100% torque, 20-35% speed along with 75-100% torque, 55-70% speed.

Because the sums peak at 30-35% torque, 55-60% speed is based on 4 observations, the chart of mean speed acceleration does not have a relatively large peak at this location; however the other three regions cited above for sums include relatively large mean speed accelerations, with a maximum of 64 at 95-100% torque, 65-70% speed. Other smaller local maximums are in regions of 25-60% torque and spread over the speed axis.

Few standard deviations values are found, reflecting the scarcity of speed accelerations data. Three peaks are: 21 at 30-35% torque, 55-60% speed; 18 at 40-45% torque, 60-65% speed; and 13 at 40-45% torque, 35-40% speed.

3. SPEED DECELERATIONS--Decelerations are concentrated at 0-35% torque, 0-35% speed, including the largest deceleration count, 4, at 20-25% torque, -5-5% speed. Smaller numbers are at 30-45% torque, 50-65% speed and 65-100% torque, 85-95% speed.

The sums chart follows the counts results with most large negative values in the region 0-35% torque, 0-35% speed. Addition large negative sums occur at -5-5% torque, 60-80% speed; 40-50% torque, 40-55% speed; along with isolated values of -26 at 85- 90% torque, 0-5% speed and of -19 at 95-100% torque, 80-85% speed. The largest sum, -98, and the largest mean, -49, occur in the same locations, namely -5-0% torque, 10-15% speed.

A pattern of values, similar to those found in the sums chart, are found with the means, except that a few more individual large negative values are found, specifically at -5-5% torque, 60-80% speed and 85-90% torque, 0-5% speed.

Because of the relatively small number of observations, the standard deviations chart has few peaks, concentrated in the low torque-low speed region. The largest standard deviation is 17 at 0-5% torque, 25-30% speed.

4. SPEED STEADY STATES--Counts for steady state are highest from 0-10% torque, 0-5% speed, with a total of 158 observations. No other interval has greater than 10 observations, although some peaks are observed at 20-65% torque, 85-95% speed and also at 25-60% torque, 60-65% speed.

The sums have peaks that roughly correspond to the three speed-torque regions cited for counts. The largest sums are found at 20-75% torque, 55-65% speed. Another set of large-magnitude sums is at 15-60% torque, 80-95% speed. The 158 observations at 0-10% torque, 0-5% speed produce small sums (2.6 and -0.5) in this region, smaller than the interval (30-35% torque, 90-95% speed) producing the largest sum (4.9), in absolute value. The mean steady state speed accelerations at this low speed also is very small.

The two intervals having the most counts (at 0-10% torque, 0-5% speed) produce a mean speed change of 0 and -0.3. The torque-speed interval with the largest positive peak is at 10-15% torque, 55-60% speed, having a mean of 1.6; the torque-speed interval with the largest negative value (-2) is found in three scattered locations. Generally negative means are found at 15-25% torque, -5-0% speed and

scattered in the region 30-80% torque, 45-65% speed.

Despite the number of observations near 0% torque, 0% speed, the standard deviation of interval values is small. The largest standard deviations are found in two regions: 25-65% torque, 55-65% speed, include the torque-speed interval having the largest value, 1.9, at 50-55% torque, 60-65% speed. The other, larger region is at 15-75% torque, 85-95% speed.

5. TORQUE ACCELERATIONS--The largest number of torque accelerations, 24, occurs at 5-10% torque, 0-5% speed. Smaller numbers of counts are at 20-70% torque, 85-95% speed. Another region that includes 7 and 5 counts is at 30-45% torque, 60-65% speed.

Although 24 observations occur at 5-10% torque, 0-5% speed, the torque accelerations sum to 71. Larger sums (88, 93, 89, and 157, which is the largest torque acceleration sum) occur in the region 85-100% torque, 0-15% speed. Additional regions of high sums are at 15-40% torque, -5-0% speed; 30-65% torque, 50-65% speed; and 30-60% torque, 85-95% speed. Isolated large sums are found above 75% torque.

For the means chart, the largest means are above 60% torque. Concentrations of large means occur at 90-100% torque, both at 5-15% speed and at 30-35% speed, each containing an interval with the largest mean, 93. Additional regions of smaller, positive means are from 15-45% torque, -5-5% speed; at 50-70% torque, 50-65% speed; and at 35-60% torque, 90-95% speed.

Finally, for standard deviations, isolated peaks are at 95-100% torque, 80-85% speed (50, the maximum) and at 75-80% torque, 5-10% speed (22). A small region of high standard deviations is 55-70% torque, 85-95% speed.

6. TORQUE DECELERATIONS--The largest counts (23 and 13) are in the two intervals at 0-10% torque, 0-5% speed. Two other regions with smaller maximums are 25-40% torque, 55-70% speed, and 15-55% torque, 85-95% speed.

The largest, in magnitude, sums (-120 and -119) are in the region 15-80% torque, 85-95% speed. Isolated large magnitude sums are scattered throughout the speed-torque plane except in the region of high torque and low speed. Concentrations of negative values are at 10-40% torque, 55-70% speed and 0-10% torque, -5-5% speed.

As is the case for sums, the means have concentrations of negative values spread throughout the chart, except for high torque at low speeds. Concentrations are at 10-85% torque, 85-100% speed, including the largest (in magnitude) mean of -85.

Peak standard deviation values are at 25-40% torque, 50-65% speed, including the maximum value, 25. Regions of relatively high standard deviations occur at 15-50% torque, 85-95% speed; and 0-15% torque, 0-5% speed.

7. TORQUE STEADY STATES--Again the largest number of steady state observations are at 0 to 10% torque and 0 to 5% speed. In these two intervals, 101 observations occur. No other single interval had more than 3 observations. The same two intervals had the largest sums, again in terms of magnitudes. For the 0-5% torque and 0-5% speed interval, the sum is -18; for the 5-10% torque and 0-5% speed interval the sum is 46. No other magnitude was greater than 3 (-3 for the interval 40-45% torque, 35-40% speed).

Mean values range from -2 to +1.6. Because of the large number of observations, the mean at 0-5% torque, 0-5% speed is -.8; the mean for 5-10% torque, 0-5% speed is .6. Two regions with relatively large negative values were at 20-35% torque, -5-0% speed and at 40-45% torque and 35-45% speed. A region with both positive and negative peaks is 25-40% torque, 85-95% torque. An isolated large positive value (1.6) was at 15-20% torque and 95-100% speed.

Standard deviations were 1 at both intervals in the region 0-10% torque, 0-5% speed. Isolated values were found in the region 25-60% torque, 60-95% speed, including the largest value, 1.6.

#### A.2 *Backhoe Big Bin*

1. COUNTS--The largest counts of speed accelerations are at low speeds or at low torque. The largest value, 13, is at intermediate speed, low torque. The next largest value, 11, is at low speed, low torque.

The largest torque acceleration count is 28 at idle. Other large values are at low and medium torque, including 21 at low speed, low torque and 20 at high speed, medium torque.

2. SPEED ACCELERATIONS--The largest mean speed changes with time are at low and medium speeds, including the largest value, 40.49 at medium speed, high torque. Another large value is 33.12 at intermediate speed and high torque.

Negative values for mean torque changes with time occur at idle and at low and medium torque;



positive values tend to occur at intermediate and high torque. The largest positive value, 68.05 at low speed, high torque; the largest negative value is -45.71 at medium speed, medium torque.

3. TORQUE ACCELERATIONS--Negative values for mean speed changes with time occur at idle and at high speeds or low torque. Values range from -6.50 at low speed, low torque to 33.12 at intermediate speed, high torque.

The largest mean torque with time occur at low speed, high torque (72.54) and intermediate torque (61.40). The next largest value is 30.60 at intermediate speed, high torque.

#### B.1 *Crawler Small Bin*

1. OVERALL--Counts peak at 95-100% torque, 55-90% speed. The largest number of observations (50) occur in this region at 80-85% speed. Another region of peak counts (47) occurs at 20-25% torque, -5-5% speed. Small numbers are found in the regions 35-60% torque at 55-65% speed and 50-85% torque, 75-85% speed.

Mean speed changes tend to have high positive values at 90-100% torque, 30-65% speed, including the highest positive mean, 32, at 95-100% torque, 50-55% speed. Large negative speed changes are at -5-5% torque, 15-65% speed, and three smaller regions: at 5-10% torque, 5-20% speed; at 20-35% torque, 15-25% speed (including the largest magnitude speed change of -51 at 25-30% torque, 15-25% speed); and at 40-50% torque, 10-20% speed.

A region of large negative torque changes is below 35% torque and especially below 10% torque between 25 and 95% speed. The largest, in absolute value, change of -97 is found in this region at -5-0% torque, 75-80% speed. Another, smaller region of negative torque changes occurs at 40-75% torque, 60-95% speed. At lower speeds, regions of positive mean torque charges are at 10-40%, 30-55% torque and at 90-100% torque, 20-55% speed, which includes the positive maximum, 94, at 95-100% torque, 30-35% speed.

2. SPEED ACCELERATIONS--Speed accelerations are most frequent at 95-100% torque, 35-90% speed. Within this region the largest count of 15 is at 75-80% speed.

Peak acceleration sums generally are at 40-100% torque, 30-100% speed with an especially large concentration of high values at 95-100% torque; 45-85% speed, including the maximum speed acceleration sum of 165 at 70-75% torque.

Large means are found above 25% speed, especially for 40-100% torque. The largest mean speed accelerations is 32 at 95-100% torque, 50-55% speed.

Standard deviations are dispersed throughout the region, 40-100% torque, 40-100% speed. This region includes the maximum standard deviation of 21 at 75-80% torque, 70-75% speed. In addition, a standard deviation of 15 is at 25-30% torque, 25-30% speed.

3. SPEED DECELERATIONS--Counts peak at 95-100% torque, 70-90% speed, with a maximum of 13 at 70-75% speed.

Relatively large in magnitude sums are found at the peak numbers, 95-100% torque, 70-90% speed; and also at 95-100% torque, 25-50% speed. However, the largest sums are found at low torque, -5-5% torque, with speed 15-50%, which includes the maximum (in magnitude) sum, -92, at -5-0 torque, 45-50% speed. Smaller magnitude sums are found throughout the torque-speed plane, especially at 15-35% torque, 5-40% speed.

Relatively large-magnitude means are found at low torque, -5-10%, and speeds from 15 to 65%. Again, peak-magnitude means are widespread, although the region, 15-35% torque, 5-50% speed, contains several large in magnitude sums, including -57 at 15-20% torque, 25-30% speed. Some large negative means are also from at 95-100% torque at 30-50% speed.

The maximum standard deviation of 25 is at 55-60% torque, 55-65% speed. Other relatively large standard deviations are at -5-5% torque, 30-45% speed and 95-100% torque, 30-45% speed.

4. SPEED STEADY STATES--Relatively large steady state values occur at 20-25% torque, -5-5% speed: for -5-0% speed 8 counts are found; for 0-5% speed the maximum count, 46, is found. At 95-100% torque, 70-85% speed more large counts are observed.

The largest negative sum, -7, occurs at 20-25% torque, -5-5% speed; the largest positive sum, 7, occurs at 20-25% torque, 0-5% speed. Smaller in magnitude sums occur from 50 to 75% torque at 35 to 75% speed and at 90-100% torque, 60-85% speed. Both regions have both positive and negative sums included.

Large-magnitude means are found for torque greater than 30% and speed greater than 35%, included the most negative values (-2) and the largest positive values (2). Additional regions of

relatively large values include at 20-25% torque, -5-10% speed and 10-20% torque, 55-85% speed.

The standard deviations are generally largest for torque greater than 35% and speed greater than 50%, including the largest standard deviation (2) at 60-65% torque, 80-85% speed.

5. TORQUE ACCELERATIONS--The highest counts, 7, are found in two intervals within the region 75-100% torque, 70-85% speed. Peak regions for torque accelerations occur at 40-75% torque, 50-65% speed and at 95-100% torque, 20-60% speed.

Relatively large sums are above 30% torque and 10% speed, especially at 90-100% torque, 20-50% and 70-80% speed. The two largest sums are found at 95-100% torque and 20-25% speed (325) and 45-50% speed (314).

Peak torque acceleration means are at 95-100% torque, 20-55% speed, including the largest mean, 94, at 30-35% speed. Additional peak means are found above 30% torque and 10% speed, especially at 85-95% torque, 30-40% speed and 65-70% torque, 10-20% speed.

Relatively large standard deviations are found at 95-100% torque, 20-85% speed, including the maximum standard deviation, 38, at 40-45% speed. Isolated standard deviations are at 55-60% torque, 55-65% speed.

6. TORQUE DECELERATIONS--The largest deceleration counts are found at speeds generally greater than 40%. Three regions of peak decelerations are at 70-90% torque, 90-100% speed, including the maximum of 6 at 80-85% torque, 90-95% speed. Two other regions of relatively large counts are at 35-65% torque, 55-85% speed, and 65-85% torque, 60-85% speed.

The pattern for deceleration sums does not match the pattern for counts. Maximum magnitude sums are found at -5-5% torque, 45-55% speed and 70-85% speed. The largest (in absolute value) deceleration sum is -194 at -5-0% torque and 75-80% speed. Relatively small magnitude deceleration sums are in the regions -5-25% torque, 0-25% speed and 35-100% torque, -5-40% speed. These regions also have very small, in magnitude, mean torque decelerations.

Large magnitude mean torque decelerations are found from -5 to 5% torque, for speeds 25-40% and 45-85%. The largest mean deceleration is -99 at 0-5% torque, 60-65% speed.

The standard deviations had several isolated peaks including the largest standard deviation, 50, at 20-25% torque, 25-30% speed. Other large values were found at -5-0% torque, 45-50% speed and 30-35% torque, 70-75% speed. A region of relatively large torque is at 45-60% torque, 60-80% speed.

7. TORQUE STEADY STATES--The largest number of steady state observations, 47, occurs at 20-25% torque, 0-5% speed. A region of large steady state counts is at 95-100% torque, 60-90% speed.

Positive and negative sums are interspersed throughout the torque-speed plane, although for low torque, the sums tend to be positive and at higher torque the sums tend to be negative. Regions of relatively large in magnitude sums are found at 0 to 5 torque, 25-35 speed and 45-60% torque at 50-65% speed. The largest sum, 3, is found at 55-60% torque, 55-60% speed. Regions of relatively large negative sums are found at 60-75% torque, 70-80% speed and 95-100% torque, 75-90% speed. The largest negative sum, -4, is found at 95-100% torque, 75-80% speed.

Positive and negative torque means, ranging from -2 to 2, are interspersed throughout the torque-speed plane. The region, 0-5% torque, 20-40% speed, has a cluster of relatively large positive values, including the maximum, 2, and another relatively large value (1.9). The region, 40-55% torque, 40-65% speed, includes the largest positive value, 1.9, and the largest negative value, -2. Another region 55 to 85% torque, 60 to 85% speed, also includes both large positive and negative values.

Peaks in the standard deviations chart are scattered within the region 55-100% torque, 55-100% speed. The largest value of 1.7 is found at 80-85% torque, 80-85% speed; the interval 70-75% torque, 65-70% speed has a standard deviation of 1.4.

## B.2 Crawler Big Bin

1. COUNTS--The largest counts of speed accelerations are at high speed, with 63 at high torque, 26 at intermediate torque, and 15 at medium torque. Also, a count of 16 is at medium speed, medium torque and a count of 15 is at intermediate speed, medium torque.

Torque accelerations have large counts at high torque with the largest count, 40, at high speed; 21 at intermediate speed; and 18 at medium and low speeds. In addition, 18 is at medium speed, medium torque.

2. SPEED ACCELERATIONS--Mean speed changes with time are generally larger at intermediate to low speeds than at high speed. The largest value, 22.19, is at medium speed, high torque.

Mean torque changes with time are negative at low and medium torque. Positive values tend to

occur at intermediate and high torque. The largest positive value is 74.21 at low speed, high torque; the largest negative value is -56.05 at high speed, low torque.

3. TORQUE ACCELERATIONS--Negative values for mean speed changes with time are at idle and generally at low and medium torque. Values range from -39.77 at idle to 6.82 at medium speed, intermediate torque.

The largest mean torque changes with time are at low speed, high torque (81.34), at low speed, intermediate torque (48.25), and at medium speed, high torque (45.81).

#### C.1 *Agricultural Tractor Small Bin*

1. OVERALL--Counts are found generally at either high torque or high speed regions (75-100% torque, 90-95% speed and 90-100% torque, 85-90% speed) or at a low torque, low speed region (-5-5% torque, -5-5% speed). The maximum count on the torque-speed plane is 130 at 90-95% torque, 90-95% speed).

Mean speed changes, which include accelerations and decelerations, are generally spread over the region, 25-65% torque, 25-70% speed. Individual, large-magnitude speed changes are -35, which is the largest magnitude change, at 25-30% torque, 30-35% speed; 28, which is the largest positive change, at 60-65% torque, 50-55% speed; 24 at 55-60% torque, 20-25% speed; 18 at 35-40% torque, 60-65% speed; and -23 at 50-55% torque, 65-70% speed.

Mean torque changes also have isolated relatively large magnitude values, except for a region of both positive and negative changes at 40-90% torque, 90-100% speed. The largest magnitude mean torque changes are isolated with 56, the largest magnitude change, at 55-60% torque, 20-25% speed; -35 the largest magnitude negative change at 25-30% torque, 45-50% speed; and -31 at 20-25% torque, 95-100% speed.

2. SPEED ACCELERATIONS--Large counts occur in the region 90-100% torque, 70-95% speed. This region includes two intervals, 90-95% torque, 85-90% speed and 95-100% torque, 70-75% speed, which have 8 counts, the largest count for any single interval. Some additional positive counts are found from 50-90% torque, 95-100% speed.

The largest sums occur in the region 90-100% torque, 70-95% speed, including the maximum sum, 51, at 95-100% torque, 70-75% speed. Three relatively large and isolated sums are 28 at 60-65% torque, 50-55% speed; 24 at 55-60% torque, 20-25% speed; 18 at 35-40% torque, 60-65% speed. Because these three isolated sums each correspond to one count, their means are 28, 24, and 18, respectively.

The 28 speed acceleration mean is the largest mean, followed by 18. A few relatively small means are found at 80-100% torque, 80-100% speed.

Relatively large standard deviations are at 90-100% torque, 70-100% speed including the interval, 90-95% torque, 85-90% speed, with the largest standard deviations, 7.

3. SPEED DECELERATIONS--The peak counts for speed decelerations occur at 90-100% torque, 55-95% speed, including the three intervals with the maximum count, 8. These intervals are at 90-95% torque, 85-95% speed and 95-100% torque, 80-85% speed. Another region with relatively large counts occurs at 60-90% torque, 90-95% speed.

The two largest magnitude sums, and means, occur as isolated points, a -35 sum at 25-30% torque, 30-35% speed and a sum of -31 at 0-5% torque, -5-0% speed. Regions of relatively large in magnitude means occur at 90-100% torque, 60-95% speed and at 60-90% torque, 90-95% speed.

Besides the two isolated points, each having 1 observation and maximum means of -35 and -31, a few relatively large magnitude means are at 95-100% torque, 60-80% speed; and at 70-75% torque, 90-95% speed.

Standard deviations are largest at 95-100% torque, 60-85% speed, including the largest standard deviation of 4.2 at 75-80 speed. Other positive values are found in the region 85-95% torque at 85-95% speed.

4. SPEED STEADY STATES--Large counts are at 90-100% torque, 80-95% speed including the largest count, 115, at 90-95% torque, 90-95% speed. Additional regions of relatively large counts occur at 75-90% torque, 90-95% speed, and -5-5 torque, -5-5 speed.

Relatively large sums are found in three regions, each have large positive and negative sums. The region, 75-95% torque, 90-100% speed, contains the largest negative sum, -16 at 90-95% torque, 90-95% speed. The largest positive sums, 14, are at the 2 intervals: 85-95% torque, 95-100% speed. Other regions with relative large values are at 95-100% torque, 65-80% speeds and -5-5% torque, -5-5%

speed.

Speed steady states have peak means at 50-95% torque and 90-100% speed. The largest negative values, -2, and positive values are found in the region. The largest positive mean, 1.9, is at 40-45% torque, 95-100% speed. Other regions of large positive and negative means are 90-100% torque, 70-90% speed and -5-5% torque, -5-5% speed.

Three regions of relatively large standard deviations are found. These are at -5-5% torque, -5-5% speed; 90-100%, 65-90% speed; and 50-95% torque, 90-100% speed. The last region contains the largest standard deviation, 1.4, at 50-55% torque, 95-100% speed.

5. TORQUE ACCELERATIONS--The largest counts are found at 75-100% torque, 90-95% speed, including the maximum interval count of 41 at 90-95% torque, 90-95% speed.

The region of largest counts is within the region of largest sums, 60-100% torque, 90-95% speed. The largest interval sum of 175 is at 90-95% torque, 90-95% speed. Other large sums are found at 90-100% torque, 85-90% speed and at an isolated interval with a sum of 56 at 55-60% torque, 20-25% speed.

The two largest means are found at isolated intervals: 63 at 90-95% torque, 85-90% speed; 56 at 55-60% torque, 20-25% speed. A region with large means is found at 60-85% torque, 90-100% speed.

The region of largest standard deviations extends from 60-100% torque, 90-100% speed, with a maximum of 9.8 at 60-65% torque, 90-95% speed.

6. TORQUE DECELERATIONS--Large counts are found in the region 85-95% torque, 85-100% speed, including the largest count of 24 at 85-90% torque, 90-95% speed. Another, adjacent region of relatively large counts is at 70-85% torque, 90-100% speed.

Generally the largest magnitude sums are in two regions, although scattered, isolated large values also are found. The region with the largest magnitude sums are from 70-95% torque, 80-100% speed and from 40-60% torque, 90-100% speed. The largest magnitude interval sum of -84 is at 85-90% torque, 90-95% speed. Isolated intervals, each having but one count, have the following sums: -29 at 50-55% torque, 65-70% speed; -35 at 25-30% torque, 45-50% speed; -21 at 25-30% torque, 30-35% speed; -31 at 20-25% torque, 95-100% speed; and -29 at 0-5% torque, -5 to 0% speed. Because these isolated intervals have one count, the sum equals the mean, and these values cited are means.

The largest mean is -35, at 25-30% torque, 45-50% speed. A region of relatively large in magnitude mean torque is at 40-100% torque, 90-100% speed.

At 70-95% torque, 90-100% speed is a region of relatively large standard deviations. The largest standard deviation, 11, is at 50-55% torque, 95-100% speed.

7. TORQUE STEADY STATES--Positive counts are generally found within three regions in the torque-speed plane. The regions with the largest counts, at 80-100% torque, 85-95% speed, include the maximum count, 72, at 90-95% torque, 90-95% speed. Other large counts are found at 95-100% torque, 65-85% speed and -5-5% torque, -5-5% speed.

Torque steady state sums range from -3 to 23. Each region to be described contains both relatively large positive and negative sums. Two sums of -3 and one of 23 are found from 90-100% torque, 60-90% speed. Additional regions having large magnitude sums are 70-85% torque, 90-95% speed; 85-100% torque, 90-100% speed; and -5-5% torque, -5-5% speed.

Large magnitude means occur from 65-95% torque, 90-100% speed including the biggest mean, 1.9, at 65-70% torque, 95-100% speed. Another region of large-magnitude means is 90-100% torque, 60-95% speed, which includes the largest, in magnitude, negative value of -1.6 at 90-95% torque, 70-75% speed. The region -5-5% torque, -5-5% speed also contains large negative and positive values.

The largest standard deviation is 1.6 at the isolated interval, 60-65% torque, 95-100% speed. Additional relatively large standard deviations occur at 70-100% torque, 90-100% speed and within 90-100% torque, 60-90% speed. The final region with large values is -5-5% torque, -5-5% speed.

## C.2 *Agricultural Tractor Big Bin*

1. COUNTS--Almost all counts of speed accelerations are at high speed, high torque (a count of 42). In addition, a count of 9 is at intermediate speed, high torque.

The largest torque acceleration count, 107, is also at high speed, high torque (a count of 107). The next largest count, 13, is at high speed, intermediate torque.

2. SPEED ACCELERATIONS--The largest mean speed changes, based on a single count each, are 28.07 at medium speed, intermediate torque; 24.21 at low speed, medium torque; and 17.96 at intermediate speed, low torque. The speed acceleration mean for high speed, high torque is 3.48, based on a count of 42.

The largest mean torque change with time is 55.57, at low speed, medium torque, but the mean is based on only one observation. The largest negative value, -17.15, at high speed, medium torque, is from 5 observations; 0.67 at high speed, high torque results from 42 observations.

3. TORQUE ACCELERATIONS—As was the case for means speed changes for speed accelerations, the largest mean speed changes, based on a single count each, are 28.07 at medium speed, intermediate torque; 24.21 at low speed, medium torque; and 17.96 at intermediate speed, low torque. At high speed and torque, the mean speed change with time is negative, -.11, based on 107 observations. The largest negative value, -3.06, at intermediate speed, low torque is based on 1 observation.

Large positive mean torque changes with time occur at low to intermediate speed, low to intermediate torque, including the largest positive value, 55.57, at low speed, medium torque. Only one count produces this mean. At high speed, high torque, where there are 42 observations, the mean is 0.67. The largest negative value, -17.15, at high speed, medium torque is based on 1 observation.

#### D.1 *Welder—Typical 1 Small Bin*

Four Welder cycles were considered, Typical 1, Typical 2, High Speed Transient, and High Torque Transient. Observations from each will be presented below.

1. OVERALL—Counts are highest at 95-100% speed, 10-35% torque, with the largest count of 363 at 15-20% torque. Large counts are found at 5-10% torque, -5-5% speed, including 115 at 5-10% torque, 0-5% speed.

Mean speed changes with time tend to be positive at 60% torque and higher, except for the isolated value of -79 at 70-75% torque, -5-0% speed. In addition to -79, which is the largest negative speed change, the largest positive speed change 101, is at 70-75% torque, 100-105% speed. Large negative speed changes are found at 5-10% torque, especially above 40% speed, with a large negative value, -65, at 5-10% torque, 40-45% speed.

A few low-magnitude negative mean torque changes occur at 10-35% torque, 100-110% speed, with the largest magnitude negative torque mean of -8.6 at 30-35% torque, 105-110% speed. Large positive torque means are scattered above 50% torque with the largest positive torque means, 68.1 at 70-75% torque, -5-0% speed. Other large positive torque means are 66.6, at 70-75% torque, 100-105% speed; 54.2 at 60-65% torque, 25-30% speed; and 47.9 at 50-55% torque, 35-40% speed.

2. SPEED ACCELERATIONS—Positive counts are found from 15 to 75% torque, and above 95% speed, with the largest count of 6 at 20-25% torque, 105-110% speed. Another isolated positive count of 4 is at 5-10% torque, 0-5% speed.

Relatively large sums are within the region 50-75% torque, 95-105% speed. The largest sum is 174 at 50-55% torque, 95-100% speed. Some isolated, positive sums are found at 5-25% torque, no positive sums are above 75% torque.

Means follow the pattern set by the sums. Most positive means are relatively isolated with a maximum of 101 at 70-75% torque, 100-105% speed. A region of several positive means is from 50 to 75% torque, 95-105% speed. Isolated, positive means are found 5-20% torque, at speeds above 15%. No positive values are found above 75% torque over all speeds.

Because there are few counts, there are few positive standard deviations. The largest standard deviation is 20.6 at 50-55% torque, 95-100% speed. A value of 2.8 is found at 15 to 20% torque, 105-110% speed.

3. SPEED DECELERATIONS—The largest speed deceleration count is 5 at 5-10% torque, -5-0% speed. Individual counts are in the range 5-10% torque, 40-95% speed; and a region of relatively large counts (1 to 3) is found at 35-55% torque, 95-100% speed.

The largest magnitude sums are at 5-10% torque, at all speeds, and the absolute value of the sums for this torque decrease with faster speeds, so that the maximum deceleration, -250, is at -5-0% speed and decreases to -30, -23, -21 and -11 at 75-95% speed. An isolated sum of -79 is at 70-75% torque, -5-0% speed.

Mean speeds also have highest magnitude values at 5-10% torque with -92 at 0-5% speed and -62 at -5-0% speed. A region of high magnitude means is 5-10% torque, 40-95% speed. The isolated single observation at 70-75% torque, -5-0% speed, produces a -79 mean.

The largest standard deviation is 19.9 at 5-10% torque, -5-0% speed. The only other standard deviations are at 35-55% torque, 95-100% speed.

4. SPEED STEADY STATES—Much higher counts are found in this case. Instead of a

maximum of 5 or 6 counts, the speed steady state maximum is 362 at 5-20% torque, 95-100% speed, included in a region of large counts from 10-35% torque and 95-100% speed. Another region of relatively large counts is at 5-10% torque, -5-5% speed including a count of 114 at 0-5% speed.

Non-zero sums are in just two regions, 5-70% torque, 95-110% speed and 5-10% torque, -5-5% speed with positive and negative sums interspersed. Relatively large positive sums are 5.3 and 5.6 at 20-30% torque, 100-105% speed; the largest magnitude negative sum is -4.2 at 20-25% torque, 95-100% speed. Sums of .2 is found at 5-10% torque, 0-5% speed and -.4 at 5-10% torque, -5-0% speed.

Positive and negative means are interspersed in the region 5-70% torque, 95-110% speed. The largest positive sum, 1.4, is found in two locations, 40-45% torque and 65-70% torque, both at 100-105% speed. The largest negative sums in this region are -.7 at 25-30% torque, 105-110% speed, and -.6 at 45-50% torque, 95-100% speed.

For standard deviations, positive values are found within the region 5-55% torque, 95-110% speed, with a maximum of 1.1 at 45-50% torque, 95-100% speed.

5. TORQUE ACCELERATIONS—The largest counts are from 15-45% torque, 95-110% speed, especially at 95-100% speed. The largest number of counts, 47, is at 20-25% torque, 95-100% speed.

The largest acceleration sums are found in the region 15-75% torque, 95-105% speed, with the largest sum, 191, at 20-25% torque, 95-100% speed. A few isolated sums are scattered over the torque-speed plane, with the biggest, isolated sum of 68.1 at 70-75% torque, -5-0% speed.

Large means are from 45-75% torque, 85-105% speed and smaller, positive means are within 15-45% torque, 95-110% speed. Larger values, for isolated, single-point means are at 50-75% torque and speeds below 45%, including the largest mean, 68.1, at 70-75% torque, -5-0% speed.

Standard deviations are largest within 30-70% torque, 95-100% speed, including the largest standard deviation, 20.6 at 65-70% torque. A region of smaller standard deviations is at 10-30% torque, 90-105% speed.

6. TORQUE DECELERATIONS—All positive counts are within 5-55% torque and 95-110% torque except for a count of 1 at 5-10% torque, -5-0% speed. The largest counts are 83 at 15-20% torque, 95-100% speed and 81 at 20-25% torque, 95-100% speed.

Almost all non-zero sums are at 10-55% torque, 95-110% speed, especially at 15-40% torque, 95-100% speed, which includes the largest magnitude sum, -333, at 20-25% torque.

Large magnitude means are included in two regions, 5-35% torque, 100-110% speed and 15-55% torque, 95-100% speed, which includes the largest magnitude sum, -15, at 50-55% torque. An isolated mean, -7.1, is at 65-70% torque, 95-100% speed.

Positive standard deviations are from 5-25% torque, 100-110% speed and 15-55% torque, 95-100% speed, which includes the largest value, 7.1, at 45-50% torque.

7. TORQUE STEADY STATES—Relatively large positive counts are at 5-30% torque, 95-110% speed, and 5-10% torque, -5-5% speed. The largest count is 253 at 15-20% torque, 95-100% speed.

Relatively large magnitude sums are at 5-30% torque, 95-110% speed including the largest positive sum, 15.2, at 20-25% torque, 95-100% speed and the largest-magnitude negative sum, -49, at 15-20% torque, 95-100% speed. Two negative sums, -1.1 and -1.8 are found on the interval 5-10% torque, -5-5% speed.

Non-zero means are at 5-45% torque, 95-110% speed. The largest positive mean, 1.1, is found at two locations, 15-25% torque, 105-110% speed; the largest-magnitude negative mean, -.7, also is at 2 locations, 10-15% torque, 95-100% speed and 40-45% torque, 95-100% speed.

Positive standard deviations are from 5 to 40% torque, 95-110% speed, including the largest standard deviation, 1.5, at 35-40% torque, 95-100% speed.

#### E.1 *Welder—Typical 2 Small Bin*

1. OVERALL—The largest counts are found in two regions, 5-40% torque, 95-105% speed and 5-10% torque, -5-5% speed. The maximum count, 372, is at 20-25% torque, 95-100% speed. Another large count, 349, is at 15-20% torque, 95-100% speed.

Mean speed changes with time have negative values at 5-10% torque, -5-85% speed with the largest negative value, -83, at 20-25% speed. For torque less than 5 or greater than 70, all means are 0. The largest positive speed, 86.1, is at 45-50% torque, 85-90% speed.

Mean torque changes with time have a 0 mean for torque less than 5% or greater than 80%. Torque from 5 to 15% result in primarily negative torque. Also, the region from 5-40% torque, 95-100% speed tends to have negative mean torque, including the largest negative value, -11, at 30-35% torque,

105-110% speed. Between 40 and 80% torque, the mean torque changes with time tend to be positive and scattered over the region. The largest positive mean torque change, 74.4, is at 75-80% torque, 0-5% speed. Above 80% torque, the mean torque changes are 0.

2. SPEED ACCELERATIONS—A region of large counts is at 15-60% torque, 95-110% speed. The largest count, 6, is found at 5-10% torque, 0-5% speed, and is isolated, having no nearby positive counts.

Relatively large sums are found in 20-50% torque, 95-110% speed, including the largest sum, 172, at 45-50% torque, 95-100% speed. Other large, isolated sums are 86 at 45-50% torque, 85-90% speed; 78.8 at 50-55% torque, 75-80% speed; and smaller sums at 5-70% torque.

Some relatively large means are at 35-60% torque, 75-100% speed including the largest mean, 90.4, at 45-50% torque, 95-100% speed. Isolated positive means are also at 5-70% torque.

A region of large standard deviations at 30-50% torque, 95-100% speed includes the largest value of 45.9 at 35-40% torque.

3. SPEED DECELERATIONS—Only one count is found about 50% torque; a region of relatively numerous counts is at 5-10% torque, -5-85% speed, especially the largest counts, 9, at -5-0% speed.

Large magnitude sums are in the region 5-10% torque, less than 50% speed, with the largest magnitude sum, -335, at -5-0% speed. An isolated value, -52, from one count is at 55-60% torque, 50-55% speed.

Relatively large magnitude means are from 5-15% torque, -5-85% speed, especially the region 5-10% torque, -5-45% speed, which includes the largest negative mean, -83, at 20-25% speed. The isolated value, -52, is at 55-60% torque, 50-55% speed.

The largest standard deviation, 25.3, is an isolated point at 5-10% torque, -5-0% speed.

4. SPEED STEADY STATES—The large counts are at 5-35% torque, 95-105% speed, with the biggest count, 371, at 20-25% torque, 95-100% speed and 349 at 15-20% torque, 95-100% speed. Relatively large counts are also at 5-10% torque, -5-5% speed.

A region of large-magnitude sums is at 5-60% torque, 95-105% speed, including the largest positive sum, 2.8, at 45-50% torque, 100-105% speed and the largest negative sum, -2.8, at 25-30% torque and 35-40% torque, both at 95-100% speed. An isolated large sum of -1.7 is at 65-70% torque, -5-0% speed.

Relatively large means are from 25-60% torque, 95-105% speed, which includes both positive and negative means. The largest positive mean, 1.4, is at 45-50% torque 100-105% speed. The largest-magnitude negative mean, -1.7, is an isolated value at 65-70% torque, -5-0% speed.

A region of large standard deviations is from 10-50% torque, 95-105% speed, including the largest standard deviation, 1.2, at 40-45% torque, 95-100% speed. An isolated value of .3 is at 5-10% torque, 0-5% speed.

5. TORQUE ACCELERATIONS—Large counts are at 15-35% torque, 95-100% speed, including the largest count, 43, at 20-25% torque.

Large sums are at 15-55% torque, 95-100% speed, including the largest sums, 135 at 20-25% torque and 127 at 25-30% torque. Isolated sums are within 45-80% torque, -5-95% speed, with a sum of 74.4 at 75-80% torque, 0-5% speed.

Several large means are at 45-60% torque, 35-105% speed, but the three largest means are isolated points: means of 74.4 at 75-80% torque, 0-5% speed; 61.5 at 65-70% torque, -5-0% speed; and 60 at 65-70% torque, 15-20% speed.

Standard deviations are largest from 25-50% torque, 95-100% speed, with the largest standard deviation, 21.8, at 40-45% torque, 95-100% speed.

6. TORQUE DECELERATIONS—Large counts are found in two regions, 10-20% torque, 100-105% speed and 15-40% torque, 95-100% speed, a region which includes the largest count, 59, at 20-25% torque.

Generally following the pattern of large counts, the largest magnitude deceleration sums are 10-25% torque, 100-105% speed and 15-50% torque, 95-100% speed. The latter region includes the largest negative sum, -218, at 20-25% torque, 95-100% speed.

Deceleration means also have two regions of large magnitude values: 5-35% torque, 95-110% speed, and 10-50% torque, 90-95% speed, which includes the largest magnitude mean of -16 at 45-50% torque.

Large positive standard deviations are at 15-25% torque, 100-105% speed and 20-50% torque, 95-100% speed, including the largest standard deviation, 11.5 at 45-50% torque.

7. TORQUE STEADY STATES—Large counts are in the region 10-30% torque, 95-100% speed, including the largest counts, 284 at 15-20% torque and 270 at 20-25% torque. Positive counts are also at 5-10% torque, including 96 at 5-10% torque, 0-5% speed. Two isolated, positive counts are found >35% torque, over all speeds.

Large-magnitude steady state sums are 10-25% torque, 95-100% speed, including the largest negative sum, -94, at 15-20% torque, and the largest positive sum, 5.4, at 20-25% torque. Non-zero sums are at 5-10% torque, include -31 at 100-105% speed.

Non-zero means are at 5-15% torque over all speeds, and 15-25% torque, 95-110% speed, including two intervals with the largest positive mean, .4, at 15-20% torque, 100-110% speed. The largest negative mean, -1.9, is at three intervals, 5-10% torque, 35-40% speed; 10-15% torque, 55-60% speed; and 10-15% torque, 75-80% speed.

Relatively large standard deviations are found at 5-35% torque, 95-105% speed, including the largest value, 1.4, at 20-25% torque, 100-105% speed.

#### E.2 *Welder—Typical 2 Big Bin*

1. COUNTS—The largest speed acceleration counts are at high speed: 19 at low torque and 9 at medium torque. Aside from 6 counts at idle, no other speed-torque combination has greater than 2 counts.

As for torque accelerations, the largest counts are at high speed: 112 at low torque and 14 at medium torque. All other big bin speed-torque combinations have counts no more than 2.

2. SPEED ACCELERATIONS—The largest mean speed changes with time are at medium torque: 47.15 at high speed, 39.58 at medium speed, and 36.11 at low speed. Lower means, from 18 to 20, are found for high, medium, and low speeds at low torque.

Mean torque generally are higher at lower to medium speed and medium to intermediate torque. The means range from -4.03 at high speed, low torque to 60.20 at low speed, intermediate torque. There are no high torque measurements.

3. TORQUE ACCELERATIONS—The largest negative mean speed change with time is -85.42 at idle; the largest positive mean is 36.11 at low speed, medium torque. Other large, positive values are 19.96 at both low speed, low torque and medium speed, low torque.

Mean torque changes with time increase with torque for any speed. The largest values are 74.35 at low speed, high torque and 60.78 at low speed, intermediate torque.

#### F.1 *Welder—High Speed Transient Small Bin*

1. OVERALL—Three regions of relatively high counts are found at 5-10% torque, -5-5% speed; 5-15% torque, 95-105% speed; and 15-45% torque, 95-100% speed. The largest count is 221 at 15-20% torque, 95-100% speed; a count of 109 is at 5-10% torque, 0-5% speed.

Mean speed changes with time are 0 for torque -5-5% and generally negative for torque 5-10%, with larger magnitude means at speeds 10-55%, including the largest negative mean, -91, at 10-15% torque, 10-15% speed. Several positive means changes with time generally occur for torque >20%, with a large number of positive values at speeds >100%. A region that includes four relatively large means of 63.2, 63.6, 67.4 and 71.5 is at 45-65% torque, 60-75% speed. The largest mean, 71.5, is at 50-55% torque, 70-75% speed.

Mean torque changes with time are 0 for torque -5-5%; negative (or zero) for 5-15% torque, and for the region 5-75% torque, 95-110% speed negative mean torque changes are intermixed with positive means torque changes. Mostly positive torque changes are found over the remainder of the speed-torque plane. The largest negative torque change with time is -20 at 50-55% torque, 105-110% speed; the largest positive torque changes are 71.7 at 75-80% torque, 0-5% speed and 71.3 at 75-80% torque, -5-0% speed.

2. SPEED ACCELERATIONS—Large counts are found at 15-75% torque, 100-110% speed and 35-75% torque, 95-100% speed. The largest count, 9, is at a relatively isolated interval, 5-10% torque, 0-5% speed.

A region with large sums is 35-60% torque, 95-105% speed, includes the largest sum, 301, at 35-40% torque, 95-100% speed. The 5-10% torque, 0-5% speed interval having the largest count has a sum of 33.

Large means are at 35-75% torque, 95-105% speed. The largest mean, 85.1, is at 55-60% torque, 95-100% speed. Isolated, large means are at 45-80% torque, 40-75% speed.

Positive standard deviations are at 35-55% torque, 95-105% speed. The largest standard



deviation, 65.6, is at 45-50% torque, 100-105% speed.

3. SPEED DECELERATIONS—At 5-10% torque, several positive counts are scattered for speeds -5-100%, including the largest count, 14, at -5-0% speed. Relatively high counts are 35-60% torque, 95-100% speed. Within 15-105% torque, -5-90% speed there is only one interval with a positive count.

The largest magnitude deceleration sums are at 5-10% torque, -5-75% speed. The maximum magnitude deceleration, -750, is at 5-10% torque, -5-0 speed.

Large magnitude means are in the region 5-10% torque, -5-90% speed, with the largest magnitude mean, -91, at 5-10% torque, 10-15% speed. For the region 15-105% torque, -5-90% speed there is only one non-zero mean of -2.8, at 85-90% torque, -5-0% speed.

For standard deviations, large values are obtained at 5-10% torque, -5-5% speed, with the largest standard deviation, 23.2, at 5-10% torque, -5-0 speed.

4. SPEED STEADY STATES—Two regions of relatively large counts are at 5-45% torque, 95-105% speed and 5-10% torque, -5-5% speed. The largest count, 221, is at 15-20% torque, 95-100% speed.

Both positive and negative sums are within the region at 5-75% torque, 95-105% speed. The largest positive sum, 7.0, is at 30-35% torque, 95-100% speed; the largest negative sum, -6.5, is at 5-10% torque, 100-105% speed.

Nonzero means are confined to the region 5-75% torque, 95-110% speed. The largest negative mean, -1.4, is at two intervals, 70-75% torque, 95-100% speed and 40-45% torque, 100-105% speed. The largest positive mean, .5, is also at two intervals, 55-60% torque, 95-100% speed and 40-45% torque, 100-105% speed.

Positive standard deviations are in the region 5-75% torque, 95-105% speed, including the largest value, 1.7, at 35-40% torque, 100-105% speed. One other positive standard deviation, .4, is at 5-10% torque, 0-5% speed.

5. TORQUE ACCELERATIONS—Counts of torque accelerations are largest at 15-65% torque, 95-100% speed, with the maximum value, 34, at two intervals, 20-25% torque, 95-100 speed and 30-35% torque, 95-100% speed.

Large sums are found at 15-70% torque, 95-100% speed, including the largest sum, 210, at 30-35% torque. Isolated, relatively large sums are found 45-80% torque, -5-95% speed, including 71.3 at 75-80% torque, -5-0% speed, and 71.7 at 75-80% torque, 0-5% speed.

Relatively large means are found in the region 35-90% torque, 90-105% speed; and large means primarily from single observations were found at 45-80% torque, -5-75% speed, including the two largest values, 71.3 at 75-80% torque, -5-0% speed, and 71.7 at 75-80% torque, 0-5% speed.

Positive standard deviations are at 20-90% torque, 95-105% speed, including the largest value, 16.1, at 80-85% torque, 95-100% speed.

6. TORQUE DECELERATIONS—One region of relatively large counts is at 5-50% torque, 95-105% speed. Within this region the two largest counts, 78 and 74, are found at 15-20% torque, 95-100% speed and 20-25% torque, 95-100% speed, respectively.

Large magnitude sums are found at 10-30% torque, 95-105% speed, including the largest magnitude sum, -377, at 25-30% torque, 95-100% speed. An additional region of relatively large magnitude sums is at 30-75% torque, 95-100% speed. Only zero sums are found at -5-5% torque and at 15-105% torque, -5-95% speed.

For means, relatively large magnitude values are in the region 5-75% torque, 95-110% speed, including the largest magnitude means, -20, at both 65-70% torque, 95-100% speed and 50-55% torque, 105-110% speed. A few isolated means are found at 5-15% torque, 15-80% speed.

A region of large standard deviations is at 15-75% torque, 95-105% speed, including the largest value, 9.5, at 70-75% torque, 95-100% speed.

7. TORQUE STEADY STATES—Two regions of relatively large counts are at 5-10% torque over all speeds, and at 10-40% torque, 95-105% speed, including the largest count, 125, at 15-20% torque, 95-100% speed.

Relatively large positive and negative sums are found in two regions, 5-10% torque, -5-5% speed and 5-30% torque, 95-110% speed, including the largest positive value, 5.5, at 25-30% torque, 95-100% speed and the largest negative value, -65, at 5-10% torque, 100-105% speed.

Large positive and negative means are found at 10-60% torque, 95-110% speed. This region includes the largest mean, 1.0, at 20-25% torque, 105-110% speed and the largest magnitude negative

mean, -1.6, at 25-30% torque, 100-105% speed. Non-zero means are also found at 5-10% torque.

Non-zero standard deviations are at 5-10% torque, -5-15% speed, but larger values are found in the region 5-60% torque, 95-110% speed, including the largest standard deviation, 1.6, at 15-20% torque, 100-105% speed.

#### G.1 *Welder-High Torque Transient Small Bin*

1. OVERALL—Relatively large counts are at 15-40% torque, 95-105% speed. This region includes the interval, 20-25% torque, 95-100% speed, which has the largest count, 240. Smaller positive counts are found at 5-10% torque, at both -5-5% and 100-110% speeds.

Small positive and negative mean speeds are found above 5% torque for speeds greater than 95%. For 5-60% torque, -5-95% speed there are isolated, large magnitude speeds including the largest negative mean, -80, at 5-10% torque, 20-25% speed, and the largest positive mean, 43.1 at 50-55% torque, 40-45% speed.

Large magnitude torque means are at 5-105% torque, 95-110% speed. The largest positive mean, 69.9, is at 95-100% torque, 100-105% speed; the largest magnitude negative torque are -13 at 35-40% torque, 105-110% speed and -17 at 55-60% torque, 100-105% speed. No nonzero means are at -5-5% torque and 60-105%, -5-95% speed.

2. SPEED ACCELERATIONS—The one region of relatively large counts is 15-65% torque, 95-110% speed, including the largest count, 7, at 45-50% torque, 95-100% speed. No non-zero counts are at -5-5% torque and 65-105% torque, both over all speeds.

Large sums are from 15-55% torque, 95-110% speed, including 106, the largest sum, at 45-50% torque, 100-105% speed. A few large, isolated sums are scattered outside this region, at 5-55% torque.

Non-zero means are found in the region 5-55% torque over all speeds. Relatively large means are especially concentrated at 20-55% torque, 95-110% speed. The largest value, 43.1, is an isolated point at 50-55% torque, 40-45% speed.

Large standard deviations are at 30-50% torque, 95-105% speed, with the largest value, 54.7, at 45-50% torque, 100-105% speed.

3. SPEED DECELERATIONS—Large counts are at 30-75% torque, 95-105% speed, with 8, the largest count, at 50-55% torque, 95-100% speed. A smaller region of positive counts is at 5-10% torque, -5-5% speed, with a relatively large value of 3 at 5-10% torque, -5-0% speed. Only zero counts are in the regions -5-5% torque, all speeds and 30-105% torque, -5-90% speed.

Relatively large magnitude sums are at 5-10% torque, -5-100% speed, with the largest magnitude sum, -94, at 0-5% speed. Other regions having relatively large magnitude sums are at 35-70% torque, 95-100% speed and at 10-30% torque, 15-90% speed, which contains four isolated values of -20.

Large magnitude means are at 5-10% torque, -5-100% speed, including the largest value, -94, at 0-5% speed. Four isolated values of -20 are again found at 10-30% torque, 15-90% speed.

Relatively large standard deviations are at 35-70% torque, 95-100% speed. The largest value, 3.9, is at 5-10% torque, -5-0% speed; another large, isolated value, 2.7, is at 5-10% torque, 60-65% speed.

4. SPEED STEADY STATES—Non-zero steady state counts are at 5-40% torque, 95-110% speed, including the largest count, 239, at 20-25% torque, 95-100% speed. A region of positive counts is from 5-10% torque, -5-5% speed. No counts are at -5-5% torque, over all speeds and only one positive count is in the region, 10-105 torque, -5-95% speed.

Non-zero sums are at 5-60% torque, 95-110% speed, including the largest positive sum, 17.7, at 20-25% torque, 100-105% speed and the largest-magnitude negative sum, -19, at 20-25% torque, 95-100% speed.

Most non-zero means are in the region 15-105% torque, 95-110% speed, including the largest positive mean, 1.4, at 75-80% torque, 100-105% speed, and the largest magnitude negative mean, -1, at 65-70% torque and 95-100% speed. An isolated value of -.4 is at 40-45% torque, 60-65% speed.

The region, 5-75% torque, 95-110% speed contains most positive standard deviations, with the largest value, 1.5, at 70-75% torque, 100-105% speed.

5. TORQUE ACCELERATIONS—A region of relatively large counts is at 15-70% torque, 95-105% speed, with the largest count, 27, at 20-25% torque, 95-100% speed and a count of 26 at 25-30% torque, 95-100% speed.

The largest sums are at 20-75% torque, 95-105% speed, including the largest sum, 325, at 50-

55% torque, 95-100% speed.

A concentration of large means is at 35-100% torque, 95-105% speed, including the largest mean, 69.6, at 95-100% torque, 100-105% speed. Isolated means are at 40-60% torque, -5-95% speed.

Positive standard deviations are at 20-75% torque, 95-105% speed, with the largest value, 12.6, at 65-70% torque, 100-105% speed.

6. TORQUE DECELERATIONS—Large counts are at 10-50% torque, 95-105% speed, including the largest count, 73, at 20-25% torque, 95-100% speed. Zero counts are at -5-5% torque over all speeds, and 30-105% torque, -5-95% speed.

The region, 10-65% torque, 95-110% speed, includes a concentration of large magnitude sums, including the largest magnitude sum, -273, at the two intervals in the region: 25-35% torque, 95-100% speed.

Large magnitude means are in the region, 5-65% torque, 95-110% speed. The largest mean, -17, is at three intervals, 55-65% torque, 95-100% speed and 55-60% torque, 100-105% speed. Isolated non-zero means are at 10-30% torque, -5-80% speed.

Relatively large, non-zero standard deviations are at 15-65% torque, 95-110% speed, with the largest standard deviation, 15.6, at 60-65% torque, 95-100% speed.

7. TORQUE STEADY STATES—Positive counts are at torque 5-10%, over all speeds, and 10-50% torque, 95-110% speed. The largest count, 140, is at 20-25% torque, 95-100% speed.

The largest positive and negative sums are in the region 5-30% torque, 95-110% speed. The largest positive sum, 3.7, is at 20-25% torque, 105-110% speed; the largest negative sum, -29, is at 5-10% torque, 100-105% speed.

Non-zero means are at 5-50% torque, 95-110% speed, with the largest positive value, .7, at 20-25% speed, 105-110% torque and the largest negative value, -1.4, at 10-15% torque, 95-100% speed.

Standard deviations are comparatively large within the region 5-40% torque, 95-110% speed. The largest value is 1.7 at 35-40% torque, 95-100% speed.

#### G.2 *Welder—High Torque Transient Big Bin*

1. COUNTS—Relatively large counts of speed accelerations are at high speed and lower torque. The largest count is 40 at high speed, low torque. Another large value is 17 at high speed, medium torque.

Almost all counts of torque accelerations are at high speed. The largest count, 147, is at high speed, low torque. Other large counts are 43 at high speed, medium torque, and 25 at high speed, intermediate torque.

2. SPEED ACCELERATIONS—The largest mean speed changes with time are for medium speed, at both medium torque (43.05) and low torque (19.96). Low speed, low torque also has a mean speed change of 19.96.

Negative values of mean torque changes with time occur at high speed, low and medium torque. The largest value, 46.75, is at medium speed, medium torque.

3. TORQUE ACCELERATIONS—Mean speed changes with time have the highest value, 43.05, at medium speed, medium torque. Values of 19.96 are at both medium speed, low torque and low speed, low torque. Negative values are at high speed, medium torque; high speed, intermediate torque; and intermediate speed, medium torque.

Relatively large mean torque changes with time occur at low to intermediate speeds, medium torque. The largest values are 46.75 at medium speed, medium torque and 44.32 at low speed, medium torque.

#### H.1 *Wheel Loader—Typical 1*

1. OVERALL—Counts are spread throughout much of the torque-speed plane, with an area of relatively large counts at -5-15% torque, -5-5% speed, including the largest count, 379, at 5-10% torque, 0-5% speed.

Non-zero speeds occur over a large portion of the torque-speed plane, with negative and positive values interspersed. There is, however, a tendency for negative speed changes with time at lower torque and lower speeds and for positive speed changes at higher torque and higher speeds. The range of speed changes was from -47 at 85-90% torque, 25-30% speed, to a high of 44.7 at 65-70% torque, 80-85% speed.

Changes in torque with time have a general pattern that negative values are at torque less than

40% and positive values are at torque greater than 60%, although both positive and negative values occur throughout the torque-speed plane. The largest value, 99, occurs at 85-90% torque, 25-30% speed; the smallest value, -86, occurs at two intervals, -10- -5% torque, 45-50% speed and 0-5% torque, 60-65% speed.

2. SPEED ACCELERATIONS—Relatively large counts are at 95-100% torque, 45-90% speed, including the maximum count, 26, at 70-75% speed. Other counts are scattered throughout the torque-speed plane except for primarily zero values at regions of low torque-high speed and high torque-low speed.

Large sums are at 85-100% torque, 50-90% speed, including the largest sum, 338, at 95-100% torque, 70-75% speed.

Positive means are scattered over almost the entire torque-speed plane, including the regions -5-65% torque, 15-80% speed and 65-100% torque, 35-100% speed, including the largest mean, 45.7, at 65-70% torque, 45-50% speed.

Standard deviations are relatively large at 40-100% torque, 45-90% speed, including the largest value, 35.3, at 75-80% torque, 65-70% speed.

3. SPEED DECELERATIONS—Two regions of relatively large counts are at -10-35% torque, -5-50% speed and 95-100% torque, 45-85% speed, including -8, the largest count, at 95-100% torque, 60-65% speed.

Large magnitude sums are scattered throughout the torque-speed plane, especially in the regions -10-35% torque, -5-70% speed; 40-90% torque, 35-70% speed; and 95-100% torque, 35-70% speed. The largest magnitude value, -189, is at -10- -5% torque, 30-35% speed.

Non-zero means are likewise spread throughout the torque-speed plane, except at high speeds, i.e., 85-100% speed over all torque, and 50-100% torque, -5-25% speed. The largest magnitude mean is -47 at 85-90% torque, 25-30% speed.

Most large standard deviations are at -10-40% torque, -5-60% speed, which includes the largest standard deviation, 31.6, at 10-15% torque, 35-40% speed. An isolated value, 26.8, is at 65-70% torque, 50-55% speed.

4. SPEED STEADY STATES—The largest counts are in the region 5-15% torque, 0-5% speed, with the maximum count, 373, at 5-10% torque and the next largest count, 47, at 10-15% torque. Another relatively large count, 38, is at -5-0% torque, 0-5% speed.

Positive and negative sums are interspersed throughout the torque-speed plane, except for zero sums at low torque and high speeds (-10-50% torque, 65-100% speed), and at high torque and low speeds (75-100% torque, -5-45% speed). Sums range from -2 at 25-30% torque, 45-50% speed and 95-100% torque, 60-65% speed to 3.6 at 85-90% torque, 85-90% speed.

As is the case for sums, widely dispersed positive and negative means occur at various torque and speeds, except for zero means at low torque, high speeds (10-50% torque, 75-100% speed) and for high torque, low speeds (75-100% torque, -5-45% speed). The largest mean, 1.8 occurs at 60-65% torque, 15-20% speed; the largest magnitude negative mean, -2 is at 25-30% torque, 45-50% speed and 60-65% torque, 15-20% speed.

Large standard deviations are spread over a large region, with zeros at low torque, high speed (-10-35% torque, 30-100% speed) and high torque, low speed (50-100% torque, -5-55% speed) regions. The largest values are 2.4 at 75-80% torque, 80-85% speed, 2.3 at 75-80% torque, 75-80% speed, and 2.2 at 35-40% torque, 45-50% speed.

5. TORQUE ACCELERATIONS—The highest counts are in the region 95-100% torque, 45-90% speed, including the maximum value, 13, at two intervals, 95-100% torque, 70-75% speed and 95-100% torque, 60-65% speed. Additional regions of positive counts are 35-85% torque, 45-70% speed; 15-30% torque, 20-45% speed; and 0-15% torque, 0-10% speed.

Large sums are at 95-100% torque, 45-90% speed, especially the largest sum, 521, at 95-100% torque, 55-60% speed. Another region of relatively large sums is 80-95% torque, 45-65% speed, and an isolated value of 170 at 60-65% torque, 35-40% speed.

Large means are found in two large regions. The largest means are at 65-100% torque, 25-95% speed, including the maximum mean, 99, at 85-90% torque, 25-30% speed. Another region of comparatively large means is at 25-65% torque, 0-60% speed.

There are also two regions of relatively large standard deviations, 65-100% torque, 40-90% speed, including the largest value, 41.9, at 95-100% torque, 85-90% speed. Another region that includes relatively large values is 25-65% torque, 20-55% speed.

6. TORQUE DECELERATIONS—Large deceleration counts are at -10-35% torque, -5-60% speed, including the largest count, 10, at 5-10% torque, 0-5% speed. Two smaller regions that include positive counts are 35-75% torque, 45-80% speed and 80-95% torque, 75-95% speed.

Large magnitude sums are at -10-35% torque, 0-80% speed, with the largest magnitude sum, -517, at -10- -5% torque, 45-50% speed. A few additional large magnitude sums are at 35-75% torque, 50-80% speed.

The highest magnitude means are at -10-10% torque, 45-80% speed, with the largest mean, in absolute value, -87 at 5-10% torque, 45-50% speed. Additional, large magnitude means are at -10-10% torque, -5-45% speed; 10-45% torque, 0-85% speed; and 45-100% torque, 35-100% speed.

The largest magnitude standard deviations are at -10- -5% torque, 15-50% speed, including the largest standard deviation, 60.5 at 25-30% speed. Additional regions of large values are at -5-30% torque, 20-70% speed and 30-65% torque, 45-70% speed.

7. TORQUE STEADY STATES—A region of relatively large counts is at -5-15% torque, -5-5% speed. The largest value, 366, is at 5-10% torque, 0-5% speed. Smaller counts are at 95-100% torque, 55-80% speed.

Positive and negative sums are interspersed in the three regions of relatively large magnitude values. At 95-100% torque, 35-85% speed the largest magnitude negative value, -5.3, is at 60-65% speed. The largest positive value, 6.9, is at 10-15% torque, 0-5% speed, and within the region at 0-15% torque, 0-5% speed. Another region is at 5-50% torque, 20-50% speed.

The largest positive and negative means are at 15-50% torque, 25-60% speed. The values range from -1.6 at 45-50% torque, 30-35% speed to 1.8 at 30-35% torque, 40-45% speed. Other regions having relatively large positive and negative values are at 70-100% torque, 80-95% speed and 95-100% torque, 35-70% speed.

The largest standard deviation, 1.2 at 95-100% torque, 35-40% speed, is within a region of relatively large values at 95-100% torque, 35-80% speed. An additional region of relatively large values is at 0-15% torque, 0-5% speed. An isolated value of 1.1 is at 55-60% torque, 95-100% speed.

#### *H.2 Wheel Loader—Typical 1 Big Bin*

1. COUNTS—The largest counts of speed accelerations are at high torque, namely 69 at intermediate speed, high torque and 46 at high speed, high torque.

The largest torque acceleration count of 69 is at low speed, low torque. Relatively large counts are also at high torque: a count 46 is at intermediate speed and a count of 45 is at medium speed.

2. SPEED ACCELERATIONS—The largest mean speed changes with time is 22.43 at low speed, intermediate torque and 20.55 at medium speed, intermediate torque.

Mean torque changes with time are negative at higher speeds and lower torque, whereas positive values are at lower speed and high torque. Means range from -51.54 at high speed, low torque to 43.46 at medium speed, high torque.

3. TORQUE ACCELERATIONS—Relatively large negative mean speed changes with time are -28.93 at low speed, high torque and -16.33 at idle. The largest positive values are at intermediate torque, with 20.05 at medium speed and 18.61 at high speed.

Relatively large values are at lower speed and higher torque. The largest mean, 92.63, is at low speed, high torque. Also, 53.44 is at medium speed, high torque; 52.02 is at low speed, intermediate torque.

#### *I.1 Wheel Loader—Typical 2 Small Bin*

1. OVERALL—The region of highest counts is 5-15% torque, 0-5% speed, including the two largest counts, 336 at 5-10% speed and 49 at 10-15% speed. Fewer counts are found throughout the torque-speed plane, with comparatively large values at 95-100% torque, 55-85% speed.

Mean speed changes with time are usually negative for torque 30% or less. For 60-100% torque, 40-105% speed, the values are often positive, and include 54.4, the largest positive value. The largest magnitude negative values are -44 and -49 at 85-90% torque, 20-25% speed and 90-95% torque, 20-25% speed. For the remainder of the torque-speed plane, positive and negative values are interspersed.

Mean torque changes with time are also spread over the speed-torque plane. Negative torque tend to occur at low torque, 20% or less, with the largest magnitude negative torque at -10-30% torque, 45-75% speed, including the largest magnitude value, -93 at 0-5% torque, 50-55% speed. Primarily positive values are at 70-100% torque, 20-60% speed, including the largest positive value, 73.8, at 85-

90% torque, 50-55% speed.

2. SPEED ACCELERATIONS–Non-zero counts are at 65-95% torque, 85-100% speed; and at 10-25% torque, 10-25% speed. The relatively large counts are at 95-100% torque, 50-90% speed, a region that includes the largest count, 29, at 75-80% speed.

Sums are largest in the region 95-100% torque, 55-90% speed with 431, the largest sum, at 95-100% torque, 75-80% speed. Additional regions with positive sums are at 75-95% torque, 50-60% speed and 65-75% torque, 90-100% speed.

Comparatively large means are at 40-100% torque, 20-105% speed which includes the largest mean, 50.7, at 40-45% torque, 70-75% speed. A smaller region of positive means is at 10-35% torque, 10-40% speed.

Large standard deviations are at 95-100% torque, 50-90% speed, including the largest standard deviation, 19.4, at 95-100% torque, 80-85% speed. Other regions of relatively large values are at 50-90% torque, 45-65% speed; 65-95% torque, 80-100% speed; and 10-20% torque, 35-40% speed.

3. SPEED DECELERATIONS–The largest counts are at 95-100% torque, 55-90% speed, including the largest count, 9, at both 95-100% torque, 65-70% speed and 95-100% torque, 75-80% speed. Other regions of large counts are 85-95% torque, 85-90% speed; 5-35% torque, 0-60% speed; and 35-65% torque, 45-60% speed.

Large magnitude sums are scattered throughout the torque-speed plane except at regions of low speeds at high torque (65-100% torque, -5-20% speed) and high speeds at low torque (-15-0% torque, 75-105% speed). The largest magnitude sum is -113 at 95-100% torque, 70-75% speed.

Except for regions of zero means (-15-0% torque, 70-105% speed and 65-100% torque, -5-20% speed), nonzero means are spread throughout the torque-speed plane. The largest magnitude value, -49, is at 90-95% torque, 20-25% speed.

Large standard deviations are at -10- -5% torque, 25-55% speed; 30-50% torque, 30-60% speed; and especially at 10-30% torque, 0-65% speed, a region that includes the largest value, 40.9, at 15-20% torque, 5-10% speed.

4. SPEED STEADY STATES–The largest steady state counts are at 5-15% torque, 0-5% speed, including the maximum count, 331, at 5-10% torque, 0-5% speed.

Positive and negative sums are interspersed on the torque-speed plane, except for regions containing only zero at -15-5% torque, 5-105% speed and 80-100% torque, -5-50% speed. The values range from 2.4 at both 25-30% torque, 35-40% speed and 95-100% torque, 80-85% speed to -3.5, an isolated value at 60-65% torque, 95-100% speed.

Relatively large magnitude means are especially concentrated at 10-50% torque, 10-60% speed, a region that includes the four largest magnitude negative values, -2, at 10-15% torque, 20-25% speed; 10-15% torque, 55-60% speed; 20-25% torque, 40-45% speed; and 30-35% torque, 45-50% speed. Also, the largest positive mean, 2.0 at 45-50% torque, 20-25% speed is in this region. Other regions with concentrations of large magnitude means are 75-100% torque, 75-95% speed and 50-100% torque, 50-70% speed, including the largest mean, 2.0, at 65-70% torque, 55-60% speed.

Large standard deviations are at 95-100% torque, 55-85% speed; 60-100% torque, 85-100% speed; 5-25% torque, 0-15% speed; 10-25% torque, 15-30% speed; and 15-35% torque, 35-45% speed. The largest value, 2.6, is at 10-15% torque, 25-30% speed.

5. TORQUE ACCELERATIONS–Large counts are concentrated in two regions, 5-25% torque, 0-30% speed and 65-100% torque, 50-100% speed, including 13, the largest count, at 95-100% torque, 60-65% speed.

Sums are largest at 75-100% torque, 50-90% speed, including the maximum sum, 643, at 95-100% torque, 60-65% speed.

Relatively large means are found at 40-100% torque, -5-90% speed and especially at 50-100% torque, 50-90% speed, which includes the largest mean, 73.8, at 85-90% torque, 50-55% speed.

The region, 80-100% torque, 50-95% speed, has the largest standard deviations, including the largest value, 53.9, at 95-100% torque, 85-90% speed. A smaller region of large values is at 70-85% torque, 90-95% speed.

6. TORQUE DECELERATIONS–The largest count, 10, is in two regions of relatively large counts, -10-30% torque, -5-60% speed and 60-100% torque, 85-100% speed. The maximum counts are at 10-15% torque, 0-5% speed and 70-75% torque, 90-95% speed.

Both large magnitude sums and means are throughout the torque-speed plane, except for the region at 40-100% torque, -5-45% speed, which has very few non-zero sums and means. The largest

magnitude sum, -320 is at 15-20% torque, 40-45% speed. The largest magnitude mean, -93, is at 0-5% torque, 50-55% speed.

The largest standard deviations are at -10-35% torque, 25-55% speed, including the largest value, 60.2, at 5-10% torque, 40-45% speed. Large standard deviations are also at 35-50% torque, 45-55% speed.

7. TORQUE STEADY STATES—Large counts are at -5-10% torque, -5-5% speed, including 323, the largest count by far, at 5-10% torque, 0-5% speed. Additional relatively large counts are at 95-100% torque, 55-80% speed.

Generally negative sums are in the region, 0-20% torque, 0-25% speed, including the largest negative value, -5.2, at 15-20% torque, 15-20% speed. Both positive and negative sums are at 95-100% torque, 55-85% speed, ranging from -5.2, the largest negative value, to 4.5, the largest positive value. Additional large sums are at 85-100% torque, 85-95% speed.

The largest magnitude means are found in the regions, 0-25% torque, 0-10% speed and 15-45% torque, 10-60% speed. These two regions have three intervals with the largest negative mean, -1.8, at 0-5% torque, 0-5% speed; 20-25% torque, 35-40% speed; and 30-35% torque, 45-50% speed and one interval with the largest value, 1.8, at 40-45% torque, 45-50% speed. Other intervals with smaller magnitude values are at 95-100% torque, 20-30% speed; 65-90% torque, 90-100% speed; and 85-95% torque, 85-90% speed.

Comparatively large standard deviations are at 5-20% torque, 0-20% speed; 95-100% torque, 55-85% speed; and 70-100% torque, 85-95% speed. The largest value, 1.3, occurs in two intervals, 85-90% torque, 90-95% speed and 10-15% torque, 10-15% speed.

#### J.1 *Wheel Loader—High Speed Transient Small Bin*

1. OVERALL—The largest counts are at 95-100% torque, 50-85% speed, including the maximum count, 73, at 70-75% speed. Other regions of large counts are at 70-95% torque, 85-95% speed and -5-15% torque, -5-5% speed.

Positive and negative speed changes with time are interspersed throughout the torque-speed plane, although values at low torque (-15-25% torque) tend to be negative and values at high torque (65-100% torque) tend to be positive. For all torque, positive values tend to occur at higher speeds and negative values tend to occur at lower speeds. Values range from a low of -59 at 45-50% torque, 25-30% speed to a high of 49.9 at 70-75% torque, 50-55% speed.

Negative torque changes with time predominate for torque -15-15%, and for 15-55% torque, 30-105% speed; positive values predominate for torque 55-105% and for 15-55% torque, -5-30% speed. The values range from -107 at -10- -5% torque, 65-70% speed to 98.2 at 85-90% torque, 45-50% speed.

2. SPEED ACCELERATIONS—The region of largest counts is at 95-100% torque, 50-85% speed, with 47, the largest count, at 95-100% torque, 70-75% speed.

Comparatively large sums are at 95-100% torque, 50-85% speed, including the largest sum, 497, at 70-75% speed. Another region of large sums is at 70-95% torque, 85-95% speed.

Large means are at 20-100% torque, 45-100% speed, including 49.9, the largest mean, at 70-75% torque, 50-55% speed. Other regions with large means are 20-70% torque, 20-45% speed and at -10-20% torque, 25-60% speed.

Standard deviations are largest at 5-35% torque, 15-50% speed; 35-75% torque, 25-90% speed; and 80-100% torque, 60-90% speed, including the largest value, 30.2, at 80-85% torque, 70-75% speed.

3. SPEED DECELERATIONS—The largest count, 18, is at 95-100% torque, 60-65% speed within a region of large counts at 95-100% torque, 50-85% speed. Other regions of large counts are at -5-35% torque, 0-15% speed and -10- -5% torque, 15-65% speed.

The largest magnitude sums are at -10- -5% torque, 20-75% speed, including the maximum magnitude sum, -288, at -10- -5% torque, 20-25% speed. Other comparatively large negative sums are spread within the large region, -5-75% torque, 0-65% speed, and also at 95-100% torque, 35-85% speed.

Non-zero means are found throughout two large regions, 75-100% torque, 35-95% speed and -10-75% torque, 0-85% speed. The largest magnitude mean, -59, is at 45-50% torque, 25-30% speed.

Standard deviations are relatively large at 10-45% torque, 25-45% speed, including the largest value, 37, at 25-30% torque, 25-30% speed. Other large magnitude values are at -10- -5% torque, 15-75% speed; -5-40% torque, 0-25% speed; 40-70% torque, 45-60% speed; and 95-100% torque, 50-80% speed.

4. SPEED STEADY STATES—The largest counts are at -5-25% torque, -5-5% speed, including

39, the largest count, at 5-10% torque, 0-5% speed and 38 at -5-0% torque, -5-0% speed. Another region of comparatively large counts is at 95-100% torque, 65-80% speed.

Large magnitude sums are at 0-20% torque, 0-20% speed, including the largest magnitude negative value, -5.2, at 15-20% torque, 0-5% speed. Other regions having large magnitude values are 55-60% torque, 75-85% speed and 95-100% torque, 55-85% speed including the largest positive value, 3.9, at 95-100% torque, 70-75% speed.

Although both positive and negative means are found in the region 5-50% torque, 35-100% speed, the six largest magnitude negative means are in this region, including the largest negative mean, -1.9, at 45-50% torque, 95-100% speed. Relatively large positively and negative values are found in two other regions, 50-100% torque, 55-100% speed and 0-20% torque, 0-15% speed. The largest positive value, 2, is an isolated value at -15- -10% torque, 85-90% speed.

Relatively large standard deviations are at three regions, 65-95% torque, 85-100% speed; 95-100% torque, 60-80% speed; and 5-35% torque, 0-20% speed, including the largest value, 2.1, at 30-35% torque, 5-10% speed.

5. TORQUE ACCELERATIONS—The largest counts are at 95-100% torque, 50-85% speed, including the largest count, 28, at 95-100% torque, 60-65% speed. Other large values are at -5-35% torque, 0-15% speed.

Relatively large sums are at 60-100% torque, 25-95% speed, especially in the region 95-100% torque, 45-85% speed, which includes the largest value, 1,289, at 95-100% torque, 60-65% speed.

The largest means are at 75-100% torque, 35-95% speed, including 98.2, the maximum value, at 85-90% torque, 45-50% speed. Another region of comparatively large means is at 20-75% torque, 5-70% speed.

The region, 70-100% torque, 50-95% speed, has the largest values, including 40.3, the maximum standard deviation, at 95-100% torque, 80-85% speed. Additional large values are at 55-75% torque, 25-50% speed; 45-55% torque, 10-70% speed; and 25-35% torque, 0-45% speed.

6. TORQUE DECELERATIONS—Maximum counts of 11 are found at two regions: 0-30% torque, 0-50% speed and 70-95% torque, 85-90% speed, both containing relatively large values. The maximum count of 11 is at 10-15% torque, 0-5% speed and 70-75% torque, 90-95% speed. Another region of comparatively large values is at -10- -5% torque, 15-75% speed.

The largest magnitude sums are at -10- -5% torque, 15-75% speed, including the maximum magnitude value, -824, at -10- -5% torque, 40-45% speed. Other large values are scattered through the region, -5-50% torque, 5-95% speed.

Large value means are at -10- -5% torque, 10-75% speed, including -107, the largest magnitude mean, at -10- -5% torque, 65-70% speed. Other regions of large means are at -5-20% torque, 0-65% speed; 20-30% torque, 0-15% speed; and 20-90% torque, 25-100% speed.

Relatively large standard deviations are at -10- -5% torque, 15-75% speed; 0-25% torque, 5-60% speed; 25-55% torque, 30-60% speed; and 20-60% torque, 60-80% speed. The largest value, 47.9, is at 15-20% torque, 35-40% speed.

7. TORQUE STEADY STATES—Large counts are at 95-100% torque, 60-85% speed, including the largest value, 53, at 70-75% speed. Another region of comparatively large counts is at -5-20% torque, -5-5% speed.

Positive and negative sums are interspersed in all three regions of relative large magnitude values. The regions are at -10-30% torque, 0-60% speed; 95-100% torque, 50-85% speed; and 60-90% torque, 90-95% speed. Values range from -5.3 at 70-75% torque, 90-95% speed to 10.1 at 95-100% torque, 70-75% speed.

Means also have three regions of relatively large magnitude positive and negative values. The regions are -10-0% torque, 10-40% speed; 0-25% torque 0-15% speed; and 95-100% torque, 35-70% speed. The largest magnitude negative mean is -1.7 at two intervals, 25-30% torque, 25-30% speed and -5-0% torque, 35-40% speed; the largest positive mean is 1.8 at 95-100% torque, 55-60% speed.

Large standard deviations are at 5-20% torque, 0-20% speed, including 2, the largest value, at 15-20% torque, 5-10% speed. Other relatively large values are at 85-90% torque, 85-95% speed and 95-100% torque, 50-85% speed.

#### K.1 *Wheel Loader—High Torque Transient Small Bin*

1. OVERALL—Two regions have comparatively large counts: at -5-20% torque, -5-5% speed and 95-100% torque, 50-80% speed, including the largest count, 60, at 95-100% torque, 70-75% speed. An



isolated, large count of 38 is at 70-75% torque, 90-95% speed.

Mean speed changes with time tend to be negative at low torque (-15-15%) and positive at high torque (at 80-100% torque, 45-90% speed and at 60-80% torque, 35-100% speed, which includes the largest value of 45.3 at 60-65% torque, 95-100% speed). The region 15-60% torque includes positive and negative values, ranging from 35.8 at 15-20% torque, 70-75% speed to the largest magnitude value, -52, at 50-55% torque, 40-45% speed.

Mean torque changes with time also have a region of negative values at low torque (-15-25%, including the largest magnitude negative value, -110, at -15- -10% torque, 90-95% speed) and positive values at high torque (80-100%, including the largest positive value, 100, at 95-100% torque, 45-50% speed). Generally positive values are at 25-80% torque, -5-50% speed; and generally negative values are at 25-80% torque, 50-105% speed.

2. SPEED ACCELERATIONS—The largest counts are at 95-100% torque, 55-80% speed, including the maximum count, 47, at 95-100% torque, 70-75% speed.

The region of relatively large sums, 95-100% torque, 55-85% speed, has the largest sum, 592, at 95-100% torque, 70-75% speed. Other regions of comparatively large sums are at 80-95% torque, 50-60% speed and 70-90% torque, 85-95% speed.

The largest means are also at higher torque, namely 70-100% torque, 35-95% speed, including the maximum mean, 53.9, at 90-95% torque, 60-65% speed. Other regions of comparatively large means are at 45-70% torque, 25-100% speed and -10-15% torque, 35-55% speed.

A region of large standard deviations is at 70-100% torque, 40-95% speed, including 26.5, the largest value, at 95-100% torque, 85-90% speed. As isolated value of 26.3 is at 55-60% torque, 85-90% speed. Other regions of relatively large values are at 45-75% torque, 95-100% speed and 15-70% torque, 20-60% speed.

3. SPEED DECELERATIONS—Three regions contain comparatively large counts. The regions are -15- -10% torque, 20-65% speed, including the largest count, 13, at -15- -10% torque, 35-40% speed; 0-30% torque, 0-50% speed; and 95-100% torque, 50-85% speed.

Large magnitude sums are at -10- -5% torque, 10-65% speed, including the largest negative sum, -364, at -10- -5% torque, 35-40% speed. Other regions of large magnitude sums are at 0-25% torque, 0-60% speed; 25-70% torque, 10-65% speed; and 95-100% torque, 35-80% speed.

For means a large region is at -10-60% torque, 0-75% speed, including -52 at 50-55% torque, 40-45% speed. Other regions with comparatively large means are at 60-80% torque, 15-45% speed, which includes the largest magnitude value, -53, at 60-65% torque, 35-40% speed, and at 60-100% torque, 40-90% speed.

Large standard deviations are at -10-40% torque, 0-65% speed, a region which contains the largest value, 26.6, at 35-40% torque, 10-15% speed. Other regions of large values are at 40-60% torque, 45-60% speed; 50-70% torque, 20-30% speed; and 95-100% torque, 35-80% speed.

4. SPEED STEADY STATES—Counts are largest at -5-20% torque, -5-5% speed, including 39, the maximum count, at -5-0% torque, -5-0% speed. An isolated value of 24 is at 70-75% torque, 90-95% speed.

Non-zero sums occur throughout the torque-speed plane, but there are three regions of relatively concentrated large values. Of special note is the region, 15-35% torque, 20-30% speed, which contains a large positive value, 2.4, at 30-35% torque, 25-30% speed, and the largest magnitude negative value, -3.8, at 15-20% torque, 20-30% speed. The other regions containing relatively large values are 95-100% torque, 60-75% speed and 0-25% torque, 0-15% speed, including the largest positive value, 3.0, at 15-20% torque, 0-5% speed.

Widely scattered non-zero means are found at 5-80% torque, 0-45% speed, with the largest positive means, 2.0 at 45-50% torque, 5-10% speed and the largest magnitude negative mean, -2, at 15-20% torque, 40-45% speed. Another -2 mean is at 75-80% torque, 95-100% speed, within a region of non-zero values at 55-90% torque, 85-100% speed. Other regions of comparatively large magnitude values are at 35-100% torque, 50-75% speed; -5-30% torque, 45-70% speed; and 5-45% torque, 90-95% speed.

Relatively large standard deviations are at 0-25% torque, 0-30% speed; 95-100% torque, 60-80% speed; 55-90% torque, 85-100% speed; and 35-50% torque, 60-75% speed, which contains the largest standard deviation, 1.6, at 45-50% torque, 65-70% speed.

5. TORQUE ACCELERATIONS—The largest counts are at 95-100% torque, 50-85% speed, including 27, the maximum count, at 95-100% torque, 55-60% speed.

Although positive sums are found over large portions of the torque-speed plane, the largest sums are at 95-100% torque, 50-85% speed, including the maximum sum, 1,450, at 95-100% torque, 55-60% speed.

Relatively large means are spread throughout a large portion of the torque-speed plane, namely 60-100% torque, 65-90% speed; 20-80% torque, 0-35% speed; and 25-100% torque, 35-65% speed, which includes the largest value, 106, at 95-100% torque, 35-40% speed.

Positive, relatively large standard deviations are at 30-60% torque, 15-50% speed and 60-100% torque, 40-95% speed, including the largest value, 54, at 95-100% torque, 85-90% speed.

6. TORQUE DECELERATIONS—Although comparatively large counts are at -10- -5% torque, 25-70 speed and 0-20% torque, 0-20% speed, the largest count, 17, is an isolated value at 70-75% and 90-95% speed.

The largest magnitude sums are at -10-25% torque, 5-70% speed, including the maximum magnitude sum, 1,209, at -10- -5% torque, 35-40% speed. Another small region of non-zero sums is at -15- -10% torque, 75-95% speed.

Non-zero means are widespread over the torque-speed plane. A comparatively dense concentration of non-zero values is at -10-40% torque, 0-75% speed, although the largest magnitude mean, -110, is at -15- -10% torque, 90-95% speed, within a region of relatively large magnitude values at -15-85% torque, 75-105% speed. Other non-zero means are at 40-85% torque, 40-75% speed.

Comparatively large standard deviations are at -10-30% torque, 10-60% speed, including 61.5, the largest value, at -5-0% torque, 55-60% speed. Another, smaller region of positive standard deviations is at 15-45% torque, 60-70% speed.

7. TORQUE STEADY STATES—Large counts are at 95-100% torque, 55-80% speed, including a value of 42, the largest count, at 95-100% torque, 70-75% speed. Another region of relatively large counts is at -5-15% torque, -5-5% speed.

Non-zero sums are at 0-25% torque, 0-15% speed, including 4.3, which is the largest sum, at 20-25% torque, 5-10% speed. Other regions with several non-zero values are at 55-90% torque, 90-100% speed and at 95-100% torque, 50-90% speed, including the largest magnitude negative value, -11, at 95-100% torque, 65-70% speed.

The largest magnitude means are in the region: 0-35% torque, 0-40% speed. Values range from -1.3, the largest magnitude negative value, at 25-30% torque, 20-25% speed, to 1.9, the largest positive value, at 10-15% torque, 20-25% speed. Two isolated intervals also have 1.9 means, namely at 15-20% torque, 60-65% speed and 55-60% torque, 55-60% speed. Other regions with relatively large magnitude values are at 55-90% torque, 85-100% speed and 95-100% torque, 35-90% speed.

Large standard deviations are at 5-25% torque, 5-35% speed, including 1.5, the largest value, at 15-20% torque, 10-15% speed. Other regions of large values are at 0-20% torque, 0-5% speed and 95-100% torque, 50-80% speed.

#### K.2 *Wheel Loader—High Torque Transient Big Bin*

1. COUNTS—Relatively large speed acceleration counts are at medium to high speeds and high torque. The largest count, 123, is at intermediate speed, high torque. Other large counts are 75 at medium speed, high torque and 67 at high speed, high torque.

The largest count, 108, of torque accelerations is at low speed, low torque. Relatively large counts are at medium speed, high torque (88) and at intermediate speed, high torque (71).

2. SPEED ACCELERATIONS—The largest mean speed changes with time are for medium speeds at intermediate torque (27.66) and at high torque (23.47).

Negative mean torque changes with time are at idle and low torque. High speeds at medium and intermediate torque are also negative. For a give torque, the means decrease with speed; for a given speed, the torque changes with time increase with torque. Values range from -68.10 at high speed, low torque to 83.42 at low speed, high torque.

3. TORQUE ACCELERATIONS—Mean speed changes with time are negative at idle and at low speed, low torque. Values range from -18.18 at idle to 16.86 at intermediate speed, high torque; 16.78 at medium speed, high torque; and 16.04 at medium speed, intermediate torque.

Generally, mean torque changes with time increase with torque for any speed, and decrease with speed for any torque. Values range from 10.09 at idle and 14.48 at high speed, medium torque to 61.22 at low speed, high torque.

#### L.1 *Skid Steer Loader—Typical 1 Small Bin*

1. OVERALL—Relatively large counts are at -5-5% torque, -5-10% speed; 5-40% torque, 65-70% speed; 10-30% torque, 90-100% speed; and 30-65% torque, 90-95% speed. The largest count, 127, is at an isolated interval at 5-10% torque, 30-35% speed.

Values for speed changes with time range from -59 at 10-15% torque, 20-25% speed to 36.9 at 55-60% torque, 80-85% speed. One region of comparatively large counts is at 90-95% torque, 45-65% speed.

Change in torque with time tends to have positive values at 65-100% torque, 50-100% speed including the largest positive value, 73.9, at 85-90% torque, 85-90% speed. At -10-15% torque, values tend to be negative, including the largest-magnitude negative torque change with time, -68, at -15- -10% torque, 80-85% speed. At intermediate torque of 15-65% both positive and negative values are found. The region, 30-100% torque, -5-50% speed, contains almost exclusively zero values.

2. SPEED ACCELERATIONS—Only 259 speed accelerations were observed, compared to 269 deceleration and 671 steady state observations. A region of relatively large counts is at 0-40% torque, 65-70% speed, including the largest count, 17, at 20-25% torque, 65-70% speed. Other regions of large counts are at 10-30% torque, 80-85% speed; 30-65% torque, 90-95% speed; 10-40% torque, 95-100% speed; and 0-5% torque, 5-15% speed.

Sums are largest at 10-35% torque, 95-100% speed; 10-30% torque, 80-85% speed; 5-25% torque, 65-70% speed; 45-60% torque, 70-85% speed; and 20-65% torque, 90-95% speed, including 144, the largest count, at 60-65% torque, 90-95% speed. An isolated value of 51.1 is at 95-100% torque, 85-90% speed.

Relatively large means are found scattered throughout 60-100% speed over all torque. Two regions of relatively large values are at 5-15% torque, 65-85% speed and 25-65% torque, 90-95% speed. The largest mean, 36.9, is at an isolated interval, 55-60% torque, 80-85% speed. Other isolated values are: 25.5 at 95-100% torque, 85-90% speed; 25.2 at 50-55% torque, 70-75% speed; and 18.8 at 90-95% torque, 65-70% speed.

Scattered, positive standard deviations are at speeds greater than 65%. A region of relatively large values is at 45-70% speed, 90-95% torque. Other large values are relatively isolated: 32.1, the largest value, at 50-55% torque, 70-75% speed; 25.7% at 10-15% torque, 80-85% speed; and 21 at 5-10% torque, 65-70% speed.

3. SPEED DECELERATIONS—Relatively large counts are at 15-100% torque, 60-95% speed. The largest count, 12, is in this region at 60-65% torque, 85-90% speed. A smaller region of large counts is at 0-5% torque, 0-10% speed.

Regions of relatively large magnitude sums are at 15-95% torque, 60-95% speed and 95-100% torque, 45-90% speed. The latter region includes the largest magnitude sum, -148, at 95-100% torque, 45-50% speed. Isolated large magnitude values are: -65 at 5-10% torque, 30-35% speed; -59 at 10-15% torque, 20-25% speed; and -28 at 0-5% torque, 0-5% speed.

All means in the regions -15- -5% torque for all speeds and 30-95% torque, -5-50% speed are zero. The remainder of the torque-speed plane has scattered non-zero values, with a concentration of large magnitude values at 95-100% torque, 45-65% speed. Isolated large values are -65, the largest magnitude mean, at 5-10% torque, 30-35% speed and -59 at 10-15% torque, 20-25% speed.

The largest standard deviation, 13.3, is at the isolated interval, 95-100% torque, 55-60% speed. Another relatively large value, 3.9, is at 0-5% torque, 0-5% speed.

4. SPEED STEADY STATES—Large counts are at -5-5% torque, -5-10% speed and 10-30% torque, 65-70% speed. The largest count, 125, is at an isolated interval, 5-10% torque, 30-35% speed.

A region at 10-55% torque, 60-70% speed contains the largest positive sum, 8.7, at 15-20% torque, 65-70% speed and the largest magnitude negative sum, -9.7, at 30-35% torque, 65-70% speed. Other regions with comparatively large magnitude sums are at 15-45% torque, 90-100% speed and 0-5% torque, 0-10% speed.

Positive and negative means are interspersed for speeds greater than 55% over all torque. This region includes the largest magnitude negative mean, -1.7, at 95-100% torque, 85-90% speed. A region of positive speeds is at -5-5% torque, 0-5% speed, including 2, the largest positive mean, at -5-0% torque, 0-5% speed.

Large standard deviations are at 5-85% torque, 60-100% speed. The largest standard deviation, 2.5, is at 80-85% torque, 85-90% speed. Another region of positive values are at 0-5% torque, 0-10% speed.

5. TORQUE ACCELERATIONS—Large counts are at 10-70% torque, 60-100% speed, including

the largest value, 24, at 20-25% torque, 65-70% speed. Another region of comparatively large values is at 70-100% torque, 85-90% speed.

Sums are relatively large at 65-100% torque, 85-90% speed, including 470, the largest sum, at 95-100% torque, 85-90% speed. Large sums are also at 20-65% torque, 60-100% speed.

The largest means, including the maximum, 73.9 at 85-90% torque, 85-90% speed, are in the region 70-100% torque, 55-90% speed. Comparatively large sums are also found at 15-70% torque, 60-100% speed.

Standard deviations are largest within the region 20-100% torque, 60-100% speed, including the maximum value, 18.6, at 80-85% torque, 85-90% speed.

6. TORQUE DECELERATIONS—Counts are largest in the region 5-30% torque, 65-70% speed. The maximum values, 32, at 15-20% torque, 65-70% speed, is within this region. Comparatively large counts are also at 10-65% torque, 90-100% speed.

The largest magnitude sums are at -15-60% torque, 65-100% speed. The maximum sum is -392 at 20-25% torque, 95-100% speed.

Relatively large magnitude means are in the region -15-75% torque, 60-100% speed, including -68, the largest mean, at -15- -10% torque, 80-85% speed. A few non-zero means are scattered in the region -5-40% torque, -5-60% speed.

Large standard deviations are at -15-5% torque, 95-100% speed, including the largest standard deviation, 36.8, at -15- -10% torque, 95-100% speed. Other large values are at 5-65% torque, 65-100% speed and an isolated value of 23 is at 45-50% torque, 60-65% speed.

7. TORQUE STEADY STATES—The largest count, 124, is at 5-10% torque, 30-35% speed. A region of large counts is at -5-5% torque, -5-10% speed.

The largest magnitude negative sums and some positive sums are at 15-65% torque, 60-100% speed, including the maximum magnitude negative value, -3.0, at 15-20% torque, 65-70% speed. Large positive values and a negative value are at 0-5% torque, 0-15% speed, including the maximum value, 7.4, at 0-5% torque, 5-10% speed. An isolated value of 6.3 is at 5-10% torque, 30-35% speed. Another region of positive and negative values is at 90-100% torque, 55-75% speed.

At 5-60% torque, 60-100% speed both the largest magnitude negative and positive means occur. Means range from -1.9 at 25-30% torque, 95-100% speed to 1.8 at 5-10% torque, 65-70% speed. Both negative and positive means also occur at 90-100% torque, 60-75% speed. The region, 0-15% torque, 10-30% speed, has large positive and zero means.

Large standard deviations are at 10-45% torque, 65-95% speed, including the largest value, 1.7, at 20-25% torque, 80-85% speed. Other regions of relatively large standard deviations are at 30-50% torque, 60-65% speed and 0-5% torque, 0-10% speed.

#### L.2 *Skid Steer Loader—Typical 1 Big Bin*

1. COUNTS—The largest counts of speed accelerations are at intermediate or high speeds and low or medium torque. A count of 109 at high speed, low torque, and 69 is at intermediate speed, low torque.

As was the case for speed accelerations, the largest counts of torque accelerations with time are at intermediate or high speeds and low or medium torque. The largest value, 111, is at intermediate speed, low torque. A value of 93 is at high speed, low torque.

2. SPEED ACCELERATIONS—The largest mean speed changes with time are at high and intermediate speeds. A value of 13.95 is at high speed, high torque.

Negative values for mean torque changes with time are at high speeds. Generally values increase with torque and decrease with speed. The values range from -27.71 at high speed, low torque to 7.00 at intermediate speed, high torque.

3. TORQUE ACCELERATIONS—Mean speed changes with time are all negative. The largest negative values are at medium speed, namely -13.10 at high torque and -7.23 at medium torque.

The largest mean torque changes with time are at high torque, namely 38.79 at high speed; 35.79 at intermediate speed; and 34.59 at medium speed.

#### M.1 *Skid Steer Loader—Typical 2 Small Bin*

1. OVERALL—The largest count is 268 at 0-5% torque, 25-30% speed. Regions of comparatively large counts are at 10-25% torque, 65-70% speed and 20-35% torque, 95-100% speed.

Speed changes with time are generally positive in the region -10-20% torque, 50-105% speed. This region includes the largest positive value, 40.1 at 0-5% torque, 75-80% speed. The largest

magnitude negative value, -37, at 5-10% torque, 25-30% speed, is within a region of relatively large positive and negative values at 0-10% torque, 15-30% speed. Another region of both positive and negative values is at 35-100% torque, 50-90% speed.

Above 35% torque, torque changes with time are non-negative. Positive values are found at 35-80% torque, 55-100% speed and the largest positive value, 84.9, is at the interval 95-100% torque, 50-55% speed. Negative values are at -20-10% torque, 65-105% speed, although the largest magnitude negative value, -71, is at 5-10% torque, 15-20% speed.

2. SPEED ACCELERATIONS—Total counts for both speed accelerations (121) and decelerations (119) are small compared to the counts for speed steady states (959). For accelerations, there are two regions of relatively large counts, at 0-20% torque, 65-70% speed and 20-35% torque, 95-100% speed, including 11, the largest count, at 20-25% torque, 95-100% speed.

Large sums are at two regions, 20-40% torque, 85-100% speed and -5-25% torque, 65-70% speed, including the largest sum, 71.8, at 0-5% torque 65-70% speed. Relatively large, isolated values are at two intervals, a value of 40.1 at 0-5% torque, 75-80% speed and 23.2 at 95-100% torque, 50-55% speed.

Most large means are widely scattered in the region 0-40% torque, 15-105% speed, including the largest mean, 40.1, at 0-5% torque, 75-80% speed. An isolated value of 23.2 is at 95-100% torque, 50-55% speed.

The largest standard deviations are at isolated points, 26.8 at 35-40% torque, 85-90% speed and 17.4 at 0-5% torque, 65-70% speed. Relatively large values are at 10-30% torque, 95-100% speed.

3. SPEED DECELERATIONS—Large counts are at 15-65% torque, 60-70% speed. This region includes the largest count, 8, at 40-45% torque, 60-65% speed. An additional region of large counts is at 20-70% torque, 85-100% speed.

The largest magnitude sums are at 0-10% torque, 25-40% speed, including the maximum magnitude sum, -108, at 0-5% torque, 25-30% speed. Other relatively large values are at 20-55% torque, 60-70% speed; 25-45% torque, 85-100% speed; and 45-65% torque, 90-95% speed.

Relatively large magnitude means are at 0-10% torque, 15-40% speed. The largest magnitude mean, -72, is within this region at 5-10% torque, 25-30% speed.

The largest standard deviation, 16, is in an isolated interval, 0-5% torque, 25-30% speed.

4. SPEED STEADY STATES—The largest count, 265, is at an isolated interval at 0-5% torque, 25-30% speed. Some large values are at 10-25% torque, 65-70% speed.

The largest positive sum, 10.5, is at 0-5% torque, 65-70% speed, within a region, -5-10% torque, 65-70% speed of positive and negative values. Also within a region of positive and negative values, 15-40% torque, 60-70% speed, is the largest magnitude negative value, -7.5, at 20-25% torque, 65-70% speed. Other regions of relatively large values are at -5-15% torque, 25-30% speed; -10-10% torque, 90-100% speed; 10-50% speed, 85-100% speed; and 50-75% torque, 80-95% speed.

Relatively large means are generally at -20-75% torque, 65-100% torque, including -2, the largest magnitude mean, at both 45-50% torque, 80-85% speed and 40-45% torque, 95-100% speed. In addition, the largest positive mean, 1.2, is at 75-80% torque, 25-30% speed; -1.5 is at 5-10% torque, 25-30% speed.

There are two regions of large standard deviations, both having one interval with the largest value, 1.5. The regions are -5-50% torque, 60-70% speed, with 1.5 at 30-35% torque, 65-70% speed and -5-60% torque, 85-100% speed, with 1.5 at 20-25% torque, 90-95% speed.

5. TORQUE ACCELERATIONS—Total torque counts are greater for accelerations (327) and decelerations (356) and less for steady states (516) than was the case for total speed counts. For accelerations, there are two regions of large counts, each having an interval of the maximum value, 17. The regions are 0-65% torque, 85-100% speed, with 17 at 20-25% torque, 95-100% speed and 5-60% torque, 60-70% speed, with 17 at 15-20% torque, 65-70% speed.

The largest sums are in two regions, 10-65% torque, 60-70% speed and especially at 15-65% torque, 85-100% speed. The maximum sum, 235, is at 55-60% torque, 90-95% speed. Isolated sums are 84.9 at 95-100% torque, 50-55% speed and 75.8 at 75-80% torque, 80-85% speed.

Relatively large means are also at two regions, 40-80% torque, 80-100% speed and 35-80% torque, 55-70% speed. The largest values are at isolated intervals, 84.9 at 95-100% torque, 50-55% speed and 68.1 at 75-80% torque, 25-30% speed.

The largest standard deviation, 25.1, at 50-55% torque, 60-65% speed, is within a region of large values, 20-60% torque, 60-70% speed. Another region of relatively large values is at 15-65% torque, 80-

100% speed.

6. TORQUE DECELERATIONS—Large counts are at -5-30% torque, 65-70% speed, including the largest count, 25, at 15-20% torque, 65-70% speed. Another region of large counts is at -5-45% torque, 85-100% speed.

Large magnitude sums are at two regions, -15-50% torque, 85-100% speed and -5-40% torque, 60-70% speed. The largest magnitude sum, -387, is at 15-20% torque, 65-70% speed; an isolated value of -71 is at 5-10% torque, 15-20% speed.

Two regions contain relatively large magnitude means, namely at -20-50% torque, 85-105% speed and -20-55% torque, 60-75% speed. The largest magnitude mean, -71, is an isolated positive value at 5-10% torque, 15-20% speed.

The largest standard deviation, 20.7, at 35-40% torque, 85-90% speed is within a region of relatively large values at -10-50% torque, 85-100% speed. Another region of relatively large values is at -5-45% torque, 60-70% speed.

7. TORQUE STEADY STATES—The largest count, 266, is a relatively isolated value at 0-5% torque, 25-30% speed. The next largest count, 44, is at 0-5% torque, 35-40% speed.

The largest positive sum, 6.8, and the largest magnitude negative sum, -4.7, are at adjacent intervals, -10- -5% torque, 95-100% speed for -4.7 and -5- 0% torque, 95-100% speed for 6.8. Both are within a region of non-zero values, -10-20% torque, 95-100% speed. Other regions with concentrations of non-zero values are 20-60% torque, 85-100% speed; -5-45% torque, 60-70% speed; 0-5% torque, 5-40% speed; and 5-15% torque, 25-40% speed.

Means at 0-5% torque, 5-25% speed are all -0.7. Other regions of non-zero means, containing both positive and negative values, are at 25-45% torque, 60-70% speed; 20-60% torque, 85-100% speed, including the largest positive value, 2.0, at 45-50% torque, 90-95% speed; and -10-20% torque, 95-100% speed, including the largest magnitude negative value, -1.6, at -10- -5% torque, 95-100% speed.

Large standard deviations are at 20-60% torque, 85-100% speed, including 2.8, the largest value, at 50-55% torque, 90-95% speed. Other large values are at -5-30% torque, 65-70% speed and a value of 1.1 at 25-30% torque, 60-65% speed.

#### N.1 *Skid Steer Loader—High Speed Transient Small Bin*

1. OVERALL—The largest counts are in the region 5-65% torque, 80-90% speed. The maximum count, 81, is within this region at 40-45% torque, 80-85% speed. Positive counts are also at 25-45% torque, 65-70% speed. An isolated value of 40 is at -5-0% torque, -5-0% speed.

Speed changes with time tend to be positive or zero at -25-0% torque, 40-100% speed and at 0-75% torque, 75-100% speed. Within these regions, relatively large values tend to be isolated amongst zero or small positive or negative values. The largest positive value, 53.1, is at an isolated interval, -5-0% torque, 65-70% speed. Isolated, large magnitude negative values tend to occur from -5-40% speed over all torque. The largest magnitude negative values are -70 at 90-95% torque, 0-5% speed; -69 at -20- -15% torque, 20-25% speed; and -58 at 15-20% torque, 10-15% speed. A region of negative values is at 95-100% torque, 35-60% speed.

Negative torque changes with time occur at lower torque, especially in the regions -10-50% torque, 65-95% speed and 50-65% torque, 85-90% speed. The largest magnitude negative torque, -61, is at -25- -20% torque, 75-80% speed. Positive values are at 50-80% torque, 60-65% speed, including the largest value, 91.5, at 70-75% torque, 60-65% speed. Relatively large positive values are at 80-100% torque, 30-85% speed. Other large magnitude values are 57.2 at 70-75% torque, 55-60% speed and -34 at 65-70% torque, 70-75% speed.

2. SPEED ACCELERATIONS—The high speed transient data are divided into counts for steady state (778), acceleration (206), and deceleration (215). The acceleration counts are concentrated in one region at 5-65% torque, 70-90% speed, with the maximum count, 12, at 35-40% torque, 80-85% speed.

The largest sums are at 10-70% torque, 70-90% speed. The maximum sum, 95.4 is at 45-50% torque, 80-85% speed. Some relatively large sums are at 70-75% torque, 55-65% speed, and an isolated sum of 53.1 at -5-0% torque, 65-70% speed.

Comparatively large means are at 40-65% torque, 75-85% speed and 65-75% torque, 55-85% speed. The largest mean, 53.1, is an isolated value at -5-0% torque, 65-70% speed.

The region, 40-60% torque, 70-90% speed, contains large standard deviations, including the largest value, 34.2, at 40-45% torque, 75-80% speed. Another interval, 10-15% torque, 85-90% speed,

has a standard deviation of 20.1.

3. SPEED DECELERATIONS—The largest counts are at 30-65% torque, 70-85% speed, including the maximum count, 17, at 55-60% torque, 75-80% speed. Another region of relatively large counts is at 95-100% torque, 65-80% speed.

Large magnitude sums are at several regions. The largest magnitude sum, -126, at 95-100% torque, 40-45% speed, is within a region of large values at 95-100% torque, 35-80% speed. Other regions of large magnitude sums are at 30-95% torque, 70-85% speed and -5-30% torque, -5-70% speed. Isolated sums are -70 at 90-95% torque, 0-5% speed and -69 at -20- -15% torque, 20-25% speed.

Relatively large magnitude means are at 90-100% torque, 35-85% speed and scattered in the large region -5-30% torque, -5-70% speed. The largest magnitude means are -70 at 90-95% torque, 0-5% speed and -69 at -20- -15% torque, 20-25% speed.

The largest standard deviations are at 90-100% torque, 40-80% speed, including the maximum value, 8.7, at 95-100% torque, 60-65% speed. Relatively large values are at 35-75% torque, 60-90% speed.

4. SPEED STEADY STATES—A region of large counts is at 5-55% torque, 65-90% speed, including the largest count, 66, at 40-45% torque, 80-85% speed. An isolated value of 38 is at -5-0% torque, -5-0% speed.

Relatively large magnitude sums are in the region 5-65% torque, 65-90% speed. The values range from -15 at 45-50% torque, 80-85% speed to 11 at 45-50% torque, 85-90% speed.

Large means are in the region 0-100% torque, 60-95% speed, including the largest magnitude negative value, -1.7 at 50-55% torque, 65-70% speed, and the largest positive value, 2.0, at 5-10% torque, 75-80% speed. Another region of relatively large values is at 10-20% torque, 15-25% speed.

Positive standard deviations are at 0-75% torque, 60-95% speed, including the largest value, 1.8, at 15-20% torque, 75-80% speed. An isolated value of 1.6 is at 15-20% torque, 15-20% speed.

5. TORQUE ACCELERATIONS—Unlike speed, both torque acceleration and deceleration counts are higher (both 471) than steady state counts (257). Relatively large torque acceleration counts are at 20-60% torque, 70-85% speed. The largest count, 37, is at 45-50% torque, 80-85% speed.

Large sums are at 35-70% torque, 70-85% speed, including the largest sum, 445, at 55-60% torque, 75-80% speed. Another region of relatively large sums is at 90-100% torque, 65-80% speed.

Regions of relatively large means are at 90-100% torque, 30-85% speed and 70-90% torque, 55-85% speed, including the largest mean, 91.5, at 70-75% torque, 60-65% speed. A relatively large value, 44.2, is at 20-25% torque, 70-75% speed.

Large standard deviations are at 35-100% torque, 55-90% speed, including the largest value, 29.0, at 85-90% torque, 75-80% speed. A value of 17.1 is at 95-100% torque, 40-45% speed.

6. TORQUE DECELERATIONS—Large counts are at 10-55% torque, 75-90% speed. The largest count, 40, is at 40-45% torque, 80-85% speed.

The largest magnitude sums are in the region 0-65% torque, 65-95% speed. The largest magnitude sum, -503, is at 35-40% torque, 80-85% speed. A value of -61 is at -25- -20% torque, 75-80% speed.

Non-zero means are concentrated at -10-85% torque, 65-95% speed. Scattered non-zero means are at -20-60% torque, -5-65% speed. The largest magnitude mean, -61, is an isolated value at -25- -20% torque, 75-80% speed.

Standard deviations are largest at 5-65% torque, 65-95% speed. The largest value, 23, is at 45-50% torque, 75-80% speed.

7. TORQUE STEADY STATES—The largest count, 38, is an isolated value at -5-0% torque, -5-0% speed. A region of large counts is at 5-55% torque, 80-90% speed.

Large sums are at 5-60% torque, 65-90% speed. Values range from -5.8, the highest magnitude negative value, at 45-50% torque, 80-85% speed to 5, the largest positive value, at 40-45% torque, 80-85% speed.

The largest magnitude means are at 0-75% torque, 60-95% speed with values ranging from -2 at 35-40% torque, 70-75% speed to 1.9 at 5-10% torque, 65-70% speed. Another region containing non-zero values is 90-100% torque, 50-75% speed. An isolated value of 1.1 is at 5-10% torque, 20-25% speed.

Standard deviations are relatively large at 5-65% torque, 65-90% speed. The largest value, 1.6, is at 50-55% torque, 80-85% speed.

### O.1 *Skid Steer Loader–High Torque Transient Small Bin*

1. OVERALL–Large counts are at 0-55% torque, 65-75% speed, including the largest value, 112, at 20-25% torque, 65-70% speed. An isolated count of 40 is at -5-0% torque, -5-0% speed.

Mean speed changes with time have the greatest magnitude values at 0-20% torque, -5-60% speed. The maximum positive value, 13.8, is found at four intervals, 15-20% torque, 55-60% speed; 10-15% torque, 40-45% speed; 5-10% torque, 25-30% speed; and 0-5% torque, 10-15% speed. The largest magnitude negative value, -54 is at 15-20% torque, 15-20% speed. Values are non-negative for -20-5% torque, over all speeds and non-positive for torque from 75 to 100% speed. Regions having relatively large-magnitude values are at 80-95% torque, 50-65% speed and 95-100% torque, 20-70% speed.

Mean torque changes with time have the largest magnitude negative values in the region, -20-30% torque, 65-80% speed, including the maximum magnitude negative value, -50, at -10- -5% torque, 70-75% speed. Both positive and negative values are in the region 30-60% torque, 55-75% speed.

Large positive values are in the region 70-100% torque, 85-90% speed; 95-100% torque, 20-70% speed; and 80-95% torque, 50-65% speed, including the largest positive value, 68.2, at 90-95% torque, 55-60% speed.

2. SPEED ACCELERATIONS–The number of observations for speed accelerations, 279, and for speed decelerations, 294, is much less than the observations for steady state, 626. For acceleration, relatively high counts are at 15-55% torque, 65-70% speed and 5-30% torque, 70-75% speed, including the largest value, 34, at 15-20% torque, 70-75% speed.

Sums are also large in two regions, 10-60% torque, 65-70% speed, and 0-30% torque, 70-75% speed. The largest sum, 166, is at 15-20% torque, 70-75% speed.

Large means are in two regions, 10-45% torque, 65-75% speed and 45-75% torque, 60-70% speed. The largest value, 47.6, is in an isolated interval at 35-40% torque, 95-100% speed. Other large, isolated values are 22.7 at 60-65% torque, 85-90% speed and 22.4 at 80-85% torque, 60-65% speed.

Standard deviations are large at 50-70% torque, 60-65% speed and 10-60% torque, 65-70% speed. The largest value, 19.8, is at 10-15% torque, 65-70% speed.

3. SPEED DECELERATIONS–Large counts are in three regions, 95-100% torque, 25-60% speed; 40-90% torque, 60-65% speed; and 15-60% torque, 65-70% speed. The largest count, 23, is at 30-35% torque, 65-70% speed.

The largest magnitude sum, -167 at 95-100% torque, 35-40% speed, is within a region of large values at 95-100% torque, 20-55% speed. Other regions of relatively large sums are at 20-85% torque, 60-70% speed and 85-100% torque, 55-70% speed. An isolated value of -54 is at 15-20% torque, 15-20% speed.

Concentrations of relatively large magnitude means are at 95-100% torque, 20-70% speed and 80-95% torque, 50-65% speed. Other non-zero means are scattered from -5 to 100% torque, including -54, the largest magnitude value, at 15-20% torque, 15-20% speed, -27 at 10-15% torque, 70-75% speed; and -24 at 15-20% torque, 45-50% speed.

Large standard deviations are at 95-100% torque, 35-65% speed; 40-90% torque, 60-65% speed; and 30-60% torque, 65-70% speed. The largest standard deviation, 5.5, is at the isolated interval, 95-100% torque, 85-90% speed. Another large value, 2.7, is at 70-75% torque, 85-90% speed.

4. SPEED STEADY STATES–Large counts are at 0-25% torque, 70-75% speed and at 10-50% torque, 65-70% speed, including 73, the largest count, at 20-25% torque, 65-70% speed. An isolated count of 38 is at 0-5% torque, 0-5% speed.

The region with the largest magnitude sums is at 0-30% torque, 65-75% speed, with values ranging from -16 at 20-25% torque, 65-70% speed to 19.5 at 5-10% torque, 70-75% speed. Some negative sums are at 80-100% torque, 55-65% speed. Both positive and negative sums are at 35-60% torque, 60-70% speed and 5-40% torque, 95-100% speed.

Non-zero means are widely scattered over the large region 0-100% torque, 55-100% speed. The largest magnitude negative mean, -2, is located at 95-100% torque, 60-65% speed, within the region, 90-95% torque, 55-65% speed and at 85-90% torque, 60-65% speed within the region 75-90% torque, 60-65% speed. Other regions contain relatively large magnitude positive and negative values are at 75-85% torque, 85-90% speed; 25-50% torque, 90-100% speed; 35-65% torque, 60-70% speed; and 0-10% torque, 65-75% speed, a region with includes the largest positive mean, 1.8, at 0-5% torque, 60-65% speed.

The largest standard deviation, 1.4, is found within two regions of relatively large values; 1.4 is at



60-65% torque, 60-65% speed within 0-70% torque, 60-75% speed and at 50-55% torque, 90-95% speed within 0-65% torque, 90-100% speed.

5. TORQUE ACCELERATIONS—The overall counts for accelerations (519) and decelerations (510) are much larger than the counts for steady state (170). For accelerations, large counts are at 15-65% torque, 60-70% speed, including the largest count, 50, at 20-25% torque, 65-70% torque.

Positive sums are at 95-100% torque, 35-65% speed; 15-60% torque, 65-70% speed; and 45-90% torque, 60-65% speed, including the largest sum, 734, at 60-65% torque, 60-65% speed.

Large means are at 95-100% torque, 20-70% speed. The largest mean, 68.2, at 90-95% torque, 55-60% speed, is within another region of large means, at 80-95% torque, 50-65% speed. Other concentrations of large means are at 60-100% torque, 85-90% speed, and 45-80% torque, 60-65% speed. Relatively isolated values are 36.4 at 55-60% torque, 90-95% speed and 28.4 at 5-10% torque, 65-70% speed.

Large standard deviations are found in five regions: 70-100% torque, 85-90% speed, including 33.5 the largest value at 95-100% torque, 85-90% speed; 95-100% torque, 25-65% speed; 75-90% torque, 55-65% speed; 40-75% torque, 60-70% speed; 35-65% torque, 90-95% speed.

6. TORQUE DECELERATIONS—The largest counts are at 0-30% torque, 65-75% speed, including the maximum count, 42, at 10-15% torque, 70-75% speed. Other large counts are at 30-60% torque, 65-70% speed and 5-35% torque, 95-100% speed.

The largest magnitude sums are at 0-30% torque, 65-75% speed, including the maximum magnitude value, -788, at 15-20% torque, 70-75% speed. Other relatively large values are at 30-50% torque, 65-70% speed; 50-65% torque, 60-70% speed; and 10-35% torque, 95-100% speed.

The largest means are found at two regions, -20-30% torque, 65-75% speed and 30-70% torque, 60-75% speed. The largest magnitude value, -50, is at -10- -5% torque, 70-75% speed. Other concentrations of relatively large means are at 75-90% torque, 55-65% speed and 0-70% torque, 90-100% speed; and 60-70% torque, 85-95% speed. Other non-zero values are at -5-40% torque, -5-55% speed.

Large standard deviations are at 4 regions, especially at 0-30% torque, 65-75% speed and 30-70% torque, 60-70% speed. The largest standard deviation is 31 at 30-35% torque, 60-65% speed. Other concentrations of positive values are at 10-35% torque, 95-100% speed and 40-65% torque, 90-95% speed.

7. TORQUE STEADY STATES—The largest count, 38, is at an isolated interval, -5-0% torque, -5-0% speed. Another region of relatively large values is at 5-25% torque, 65-75% speed.

The largest magnitude sums, ranging from -5.6 at 15-20% torque, 65-70% speed to 4.3 at 20-25% torque, 65-70% speed, are in the region, 5-25% torque, 65-75% speed. Other regions of large values are at 25-55 torque, 65-70% speed and 15-35% torque, 95-100% speed. A value of -2.7 is at 95-100% torque, 45-50% speed.

Several regions contain both positive and negative means. The largest positive mean, 1.9, is at 40-45% torque, 90-95% speed; the largest magnitude negative value, -1.5, at 15-20% torque, 95-100% speed is found within the region, 10-35% torque, 95-100% speed. Other regions of relatively large non-zero values are at 5-30% torque, 65-75% speed; 35-55% torque, 65-70% speed; and 95-100% torque, 45-60% speed. A value of -.8 is at 90-95% torque, 20-25% speed.

The largest standard deviation is 1.6 at 20-25% torque, 20-25% speed. Other large values are at 5-25% torque, 65-75% speed; 25-50% torque, 65-70% speed; and 20-30% torque, 95-100% speed. An isolated value of .8 is at 95-100% torque, 45-50% speed.

#### O.2 *Skid Steer Loader—High Torque Transient Big Bin*

1. COUNTS—The largest count of speed accelerations is 182 at intermediate speed, low torque. Another large count, 46, is at intermediate speed, medium torque; a count of 31 is at high speed, low torque.

Relatively large counts of torque accelerations are at intermediate speeds, for low torque (223) and for medium torque (117). Another large value (41) is at high speed, low torque.

2. SPEED ACCELERATIONS—The largest means speed change with time is 13.83 at high speed, intermediate torque. Other large means are found at medium (10.53) and low (10.61) speeds, at low torque, and at intermediate speed, medium torque (10.33).

All mean torque changes with time are negative, except 4.55 at low speed, low torque. The largest magnitude means are -37.78 at high speed, intermediate torque and -28.37 at intermediate speed, medium torque.

3. TORQUE ACCELERATIONS—Mean speed changes with time are negative for medium, intermediate and high torque. The means decrease as torque increase. Means vary from 0.05 at medium speed, low torque, to -31.37 at low speed, high torque.

Mean torque changes with time increase with torque for any speed. The largest mean, 47.33 is at intermediate speed, high torque. Other relatively large values are also at high torque, including 41.53 at low speed and 40.65 at medium speed.

#### P.2 *Excavator Big Bin*

1. COUNTS—The largest counts of speed accelerations are at high torque. The largest value, 76, is at high speed, high torque; the next largest value, 50, is at intermediate speed, high torque.

The largest counts of torque accelerations occur at high speeds. The largest values are 111 at high speed, high torque and 61 at high speed, low torque.

2. SPEED ACCELERATIONS—The largest mean speed changes with time are at intermediate torque and low speed (24.73) and medium speed (22.57). Another relatively large value, 21.75, is at intermediate speed, medium torque.

Negative values for mean torque changes with time occur at lower torque and higher speeds; positive values occur at higher torque and lower speed. The values range from 38.75 at intermediate speed, low torque, to 68.29 at low speed, high torque.

3. TORQUE ACCELERATIONS—The largest negative mean speed change with time is -34.20 at idle. The largest positive value, 22.00, is at medium speed, intermediate torque.

For any torque, values for mean torque changes with time generally increase as speed decreases. Higher values occur at high torque, with the highest value, 75.44 at low speed, high torque. Other large values are 51.65 is at low speed, intermediate torque and 51.01 at low speed, high torque.

#### Q.1 *Nonroad Transient Small Bin*

1. OVERALL—Relatively large counts are at 35-70% torque, 100-105% speed; 5-50% torque, 80-85% speed; and 70-75% torque, 75-95% speed. The largest count, 48, is at -5-0% torque, -5-0% speed.

For torque between -5 and 5%, the mean speed with time is negative. Over all torque, speeds less than 50% tend to produce negative values, including the largest magnitude value, -40, at 55-60% torque, 45-50% speed. Positive mean speeds with time tend to occur at higher speeds: 5-55% torque, 50-105% speed, including the largest positive value, 39, at 25-30% torque, 60-65% speed. Large positive values also occur at 80-100% torque, 55-105% speed.

Mean torque changes with time tends to increase with torque. At -5 to 10% torque, all large magnitude values are negative, including the largest negative value, -61, found at both -5-0% torque, 40-45% speed and -5-0% torque, 65-70% speed. Large positive values are found in the regions 35-75% torque, -5-55% speed and 85-100 torque, 55-105% speed, a region which includes the largest value, 47, at 85-90% torque, 70-75% speed. The region, 75-105% torque, -5-45% speed, has 0 for all mean torque changes with time.

2. SPEED ACCELERATIONS—Large counts for speed accelerations are found within 0-40% torque, 65-105% speed; 60-70% torque, 75-80% speed; and 95-100% torque, 60-80% speed. The largest values are at 70-75% torque, 65-95% speed, including the largest value, 11, at 70-75% torque, 80-85% speed.

The largest speed acceleration sums are from 20-100% torque, 55-105% speed. The largest value, 101, is at 35-40% torque, 65-70% speed.

Relatively large means have torque generally greater than 15% and speeds greater than 25%. A region of large means at 65-75% torque, 55-75% speed includes the largest mean speed acceleration, 40, at 70-75% torque, 60-65% speed. Large values of 38 and 39 are found at 20-30% torque, 60-65% speed.

The largest standard deviation of speed accelerations is 29 at 50-55% torque, 70-75% speed. Other relatively large standard deviations are included within 30-100% torque, 50-105% speed.

3. SPEED DECELERATIONS—Relatively large speed decelerations are at -5-40% torque, -5-50% speed and 30-75% torque, 70-95% speed. Relatively large values are at 70-75% torque, 70-95% speed, including the largest value, 7, at 75-80% speed.

Large magnitude deceleration sums are spread over the torque-speed plane, except for 10-55% torque, 80-105% speed and greater than 35% torque, -5-20% speed. The largest magnitude deceleration is -77 at -5-0% torque, 25-30% speed.

Large magnitude means are also not localized. Few large magnitude values are at -5-45% torque, 95-105% speed and at 40-100% torque, -5-25% speed. The largest magnitude mean, -44, is at 65-70% torque, 55-60% speed.

Large standard deviations are found at -5-10% torque, 0-50% speed; 15-30% torque, 25-40% speed; and 25-60% torque, 40-85% speed. The largest standard deviation is 21.9, at the isolated point, 60-65% torque, 35-40% speed.

4. SPEED STEADY STATES—Relatively large counts are at two regions: 5-75% torque, 80-105% speed and -5-5% torque, -5-5% speed. The latter region includes the largest count, 46, at -5-0% torque, -5-0% speed.

Values greater than 3 in magnitude for steady state sums are found only in the region 5-50% torque, 60-105% speed. Within this region, values range from -6 at 45-50% torque, 100-105% speed to 4 at 15-25% torque, 80-85% speed and 30-35% torque, 100-105% speed.

Steady state mean values range from -1 to 1. There are two regions with concentration of large-magnitude values, namely at 5-80% torque, 60-105% speed and at -5-20% torque, -5-20% speed. The latter region has primarily negative values, including seven values of -1, and the region, 5-80% torque, 60-105% speed, includes both 1 and -1 values.

Large standard deviations are found at 5-75% torque, 70-105% speed. The largest standard deviation, 1.2, is found at both 40-45% torque, 75-80% speed and 70-75% torque, 90-95% speed.

5. TORQUE ACCELERATIONS—The largest torque acceleration counts are in the region, 10-75% torque, 55-105% speed. This region includes the largest count, 9, at both 40-45% and 45-50% torque and 100-105% speed. Other regions with relatively large counts are at -5-45% torque, -5-40% speed and 95-100% torque, 60-105% speed.

Relatively large sums are found within 35-85% torque, 20-105% speed. The largest torque acceleration sum, 212, is at 95-100% torque, 60-65% speed, and this value adjoins another large sum, 198, at 95-100% torque, 65-70% speed.

The largest mean, 47, is at 85-90% torque, 70-75% speed. This value is within a region containing other large values at 75-100% torque, 50-105% speed. Another region with relatively large values is at 20-75% torque, 10-105% speed.

Large standard deviations are at 95-100% torque, 60-105% speed. The largest value, 28.3, at 70-75% torque, 60-65% speed within the region containing large values at 30-75% torque, 15-105% speed.

6. TORQUE DECELERATIONS—Large torque deceleration counts are found at 10-50% torque 65-105% speed. The largest count, 17, is at 20-25% torque, 80-85% speed. Another region of large counts is at 50-70% torque, 100-105% speed.

Large magnitude deceleration sums are found throughout the torque-speed plane, except for 30-105% torque, -5-50% speed. The largest magnitude sum, -203, is at 25-30% torque, 70-75% speed.

Torque deceleration means also have large magnitude values throughout the torque-speed plane, except for a high torque, low speed region defined by 35-105% torque, -5-35% speed. The highest values -61 are found at two locations, -5-0% torque, 40-45% speed and -5-0% torque, 65-70% speed.

Torque standard deviations are scattered throughout two regions, -5-20% torque, 30-85% speed and 20-70% torque, 50-105% speed. The largest value, -33.2, is at -5-0% torque, 80-85% speed.

7. TORQUE STEADY STATES—A region of relatively large steady state counts is at 70-75% torque, 75-90% speed. Aside from this there are only two isolated large values, namely 46, the largest count, at -5-0% torque, -5-0% speed and 19 at 5-10% torque, 85-90% speed.

Throughout much of the torque-speed plane, relatively small positive and negative torque sums are interspersed, except for -5-30% torque, 50-105% speed, which contains primarily negative values, and includes the largest negative value, -8, at 5-10% torque, 80-85% speed. In addition the region of intermediate to high torque and low speed (35-105% torque, -5-50% speed) has only 0 values. The largest positive value, 5, is at 70-75% torque, 75-80% speed.

Torque steady state means range from -1 to 1, and these values are spread throughout the torque-speed plane, except for regions of intermediate and high torque and low speed, in which all values are 0. Specifically 0 means are found in the regions 35-90% torque, -5-70% speed and 90-100% torque, -5-55% speed. Primarily negative or zero values, include four means of -1.0, are found within -5-25% torque, 50-100% speed.

Relatively large standard deviations are found at -5-20% torque, -5-20% speed; -5-10% torque,

45-105% speed; and 10-100% torque, 70-105% speed. The largest standard deviation, 1.4 is found at 15-20% torque, 15-20% speed; 65-70% torque, 85-90% speed; and 80-85% torque, 100-105% speed.

#### Q.2 *Nonroad Transient Big Bin*

1. COUNTS—The largest speed acceleration counts are at high speed, namely 63 at intermediate torque and 54 at low torque. Another large value is 40 at low speed, low torque.

Torque acceleration counts are largest at high speed: 63 at low torque, 73 at medium torque, and 51 at intermediate torque. Another large value, 56, is at low speed, low torque.

2. SPEED ACCELERATIONS—The largest mean speed change with time is 36.00 at medium speed, high torque. Relatively large values are 25.36 at intermediate speed, high torque and 17.87 at intermediate speed, intermediate torque.

Mean torque changes with time generally increase as speed decreases and torque increases. Values range from -20.06 at intermediate speed, low torque to 38.18 at intermediate speed, high torque.

3. TORQUE ACCELERATIONS—Mean speed changes with time are negative for low torque and positive at high torque. Values range from -12.00 at low speed, intermediate torque to 10.71 at intermediate speed, high torque.

Mean torque changes with time generally increase with torque at any speed. The largest values are 38.41 at intermediate speed, high torque and 32.30 at low speed intermediate torque.

#### R.1 *FTP DCS4 Small Bin*

1. OVERALL--Just as for agtract, backhoe, and crawler, three overall plots are presented. The largest counts (442) are at torque -5-0%, speed -5-0%. An addition region of relatively large counts, 8 to 18, are found at torque -55 to -50%, speed 60-100%. Counts are 0 over all speeds for torque greater than -50 to -5%.

Mean speed changes with time have a pattern of positive changes above 55% torque for speeds greater than 5% and negative changes for torque less than 55%. The speed change values range from -21 at 5-10% torque, 45-50% speed to 37.2 at 95-100% torque, 45-50% speed. Large negative mean speed changes are found at -55 to -50% torque, 0-90% speed. At -5-0% torque, -5-0% speed the mean speed change over 442 counts is -.1.

At -55 to -50% torque, negative mean torque changes occur, including -58 at 85-90% speed. Above -5% torque, positive and negative torque changes are interspersed, with the mean torque change ranging from -64 at 5-10% torque, 105-115% speed to 120 at 65-70% torque, 75-80% speed. Generally positive mean torque changes are found above 45% torque at speeds from -5-15%. At -5-0% torque, -5-0% speed the mean torque change over 442 counts is .8.

2. SPEED ACCELERATIONS--Above 25% torque at 70-105% speed, relatively large counts of speeds are found, including the largest value, 7, at 85-90% torque, 85-90% speed. Another region having positive counts is at -55 to -50% torque over all speeds. Several large counts are also found at torque greater than 55%.

Large speed sums are found at torque greater than 55% and 25-95% speeds, including the largest speed sum, 62.6, at 80-85% torque, 30-35% speed. Relatively high speeds are also found at -55 to -50% torque, including sums of 23.7 at 65-70% speed and 20.2 at 75-80% speed.

A region of large mean speeds is in the region more than 60% torque, 30-75% speed. This region contains the largest mean, 37.2 at 95-100% torque, 45-50% speed and 36.6 at 60-65% torque, 65-70% speed.

There are few, relatively isolated, large values for standard deviations. The largest standard deviation is 12.6 at 15-20% torque, 20-25% speed. Other relatively large values include 11.8 at 95-100% torque, 75-80% speed and 9.5 at -5-0% torque, 85-90% speed.

3. SPEED DECELERATIONS--Speed decelerations have the largest counts at torque of -55 to -50%, including the maximum value of 11 at 80-85% speed. Regions of large counts are at -55 to -50% torque, 50-90% speed and 0-25% speed. An isolated peak of 9 is at -5-0% torque, -5-0% speed. A few isolated, smaller counts are scattered above 5% torque.

Large, in magnitude, speed deceleration sums are at -55 to -50% torque, including the largest sum, -116, at 70-75% speed. Another large negative sum is -42 at -5-0% torque, -5-0% speed. Other large negative sums are scattered above 5% torque.

Large mean speed decelerations are also at -55 to -50% torque, although the largest mean, -21, is found at 5-10% torque, 45-50% speed. Relatively large, in absolute value, means are found between 5 and 80% torque, across the entire range of speeds.

A region of large standard deviations is found at -55 to -50% torque, 35-100% speed. This region includes the largest standard deviation, 19.4, at 35-40% speed. Other, more isolated, large standard deviations are 14.9 at 15-20% torque, 80-85% speed and 6.4 at 75-80% torque and 70-75% speed.

4. SPEED STEADY STATES--The largest counts by far are 433 at -5-0% torque, -5-0% speed. Regions with some positive counts are -55 to -50% torque, 70-105% speed; 0-20% torque, -5-0% speed; and scattered counts at 0-100% torque and more than 85% speed.

The steady state sums range from -6.5 at -5-0% torque, -5-0% speed to 4.8 at 85-90% torque, 90-95% speed. Negative and positive sums are at -55 to -50% torque. Relative large positive sums are within the region 40-100% torque, 75-115% speed.

Means range from -1.9 at 15-20% torque, 25-30% speed to 1.9 at both 55-60% torque, 0-5% speed and 25-30% torque, 80-85% speed. Relatively large magnitude changes are at greater than 15% torque, 55-105% speed. Also, large magnitude means occur at -55 to -50% torque, 0-20% and 55-105% speed.

Standard deviations have large values at -55 to -50% torque, especially at 50-105% speed. This region includes the largest standard deviation, 2.6, at 50-55% speed. Another region with relatively large standard deviations is at greater than 10% torque, 65-105% speed.

5. TORQUE ACCELERATIONS--Large counts are at -5-25% torque, -5-0% speed, with the largest count, 11, at -5-0% torque, -5-0% speed. Another region of large counts is 5-100% torque, 75-115% speed. For all torque less than 0, counts are 0.

The largest sum of 550 is at -5-0% torque, -5-0% speed. Additional large values are 243 at 5-10% torque, 95-100% speed; 229 at 60-65% torque, 10-15% speed; and 190 at 45-50% torque, 40-45% speed. A region containing relative large sums is 5-80% torque, 65-100% speed.

At 65-70% torque, 75-80% speed is 120, the largest mean. Other, relatively large means are at 35-50% torque, 35-50% speed and at -5-40% speed, 65-90% torque. A mean of 50 is at -5-0% torque, -5-0% speed.

The largest standard deviation, 62.7, is at 60-65% torque, 10-15% speed. A region that contains relatively large standard deviations is 5-85% torque, 65-100% speed.

6. TORQUE DECELERATIONS--The region -5-30% torque, -5-0% speed has positive counts included the largest count, 15, at -5-0% torque, -5-0% speed. The region -55 to -50% torque also has positive counts, with relatively large counts from 65-105% speed. Scattered positive counts are found at 5-95% torque, 70-105% speed.

The region with the most large-magnitude sums is at -55 to -50% torque, especially above 55% speed. This region include the largest, in absolute value, sum of -694 at 85-90% speed. A relatively large-magnitude sum is -192 at -5-0% torque, -5-0% speed. Other negative sums are scattered in the region for torque greater than 0%.

As with deceleration sums, many large-magnitude means are at -55 to -50% torque, especially above 55% speed. This region includes the three largest-magnitude means, -99 at both 100-105% speed and 85-90% speed, and -91 at 80-85% speed. The -5-0% torque, -5-0% speed interval has a mean of -14. Negative means are scattered throughout the region with torque greater than -5%, especially for speeds greater than 70%.

Standard deviations are largest in the region -55 to -50% torque, with the largest standard deviation of 31 at 100-105% speed. A region with smaller values is found at 5-45% torque, 85-105% speed.

7. TORQUE STEADY STATES--The largest count is 416 at -5-0% torque, -5-0% speed. Regions containing relatively large counts, although much smaller than 416, are at -55 to -50% torque, 60-100% speed and 65-100% torque, 80-95% speed.

Sums range from 1.9 for an isolated interval at 60-65% torque, 30-35% speed to -3.5. A region of relatively large-magnitude sums is at 70-90% torque, 85-95% speed. This region includes -3.5 at 75-80% torque, 85-90% speed and both 1.4 and 1.3 at 80-85% torque. All intervals at -55 to -50% torque sum to 0; the sum at -5-0% torque, -5-0% speed is also 0.

Because the 1.9 sum at 60-65% torque, 30-35% speed is from a single point, 1.9 is also the largest mean. Other relatively large magnitude means are found above 10% torque and at 80-105% speed, including the largest magnitude negative mean, -1.7 at 40-45% torque, 85-90% speed.

The largest standard deviation of 1.3 is at 75-80% torque, 35-40% speed. A region of relative large values is at 65-100% torque, 75-95% speed; scattered, isolated standard deviations are found at 0-

40% torque.

#### R.2 *FTP DCS4 Big Bin*

1. COUNTS—Large speed accelerations counts are at high speeds. The largest count, 41, is at high speed, high torque and the next largest count, 35, is at high speed, low torque.

Relatively large counts of torque acceleration are also at high speeds. The largest count, 44, is at high speed, low torque. Another large value, 30, is at high speed, high torque.

2. SPEED ACCELERATIONS—The largest mean speed change with time is 21.92 at intermediate speed, intermediate torque. A relatively large value of 12.97 is at low speed, high torque.

Mean torque change with time ranges from a high of 20.13 at high speed, intermediate torque to a low of -22.50 at medium speed, low torque. Torque changes with time are relatively small at high torque. 3. TORQUE ACCELERATIONS—The largest magnitude negative and positive values are at medium speed. The means range from -21.27 at low torque to 8.30 at high torque.

The largest mean torque changes are at medium speed, with 95.24 at medium torque and 58.95 at low torque.

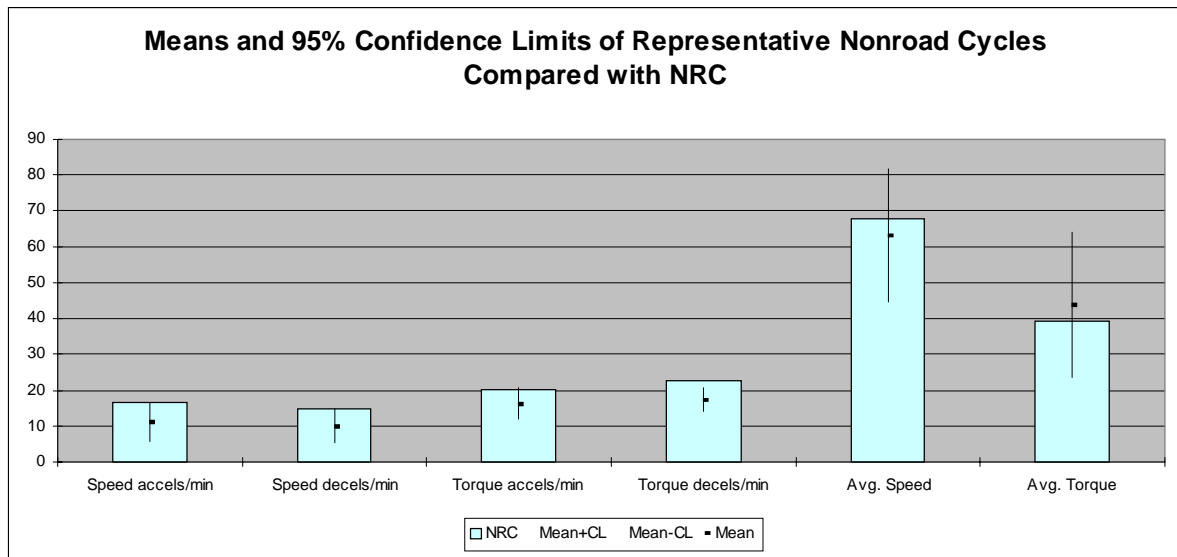
## VI. **Cycle Comparisons**

The nonroad cycle, NRC, was synthesized from the nonroad cycles, namely backhoe, agricultural tractor, crawler, and the four cycles each for welder, wheel loader, and skid steer loader. NRC is compared to three different groups of nonroad cycles based on averages for speed and torque, and the average numbers per minute of speed and torque accelerations and of speed and torque decelerations.

#### A. *NRC Comparison with 7 Representative Nonroad Cycles*

The 7 representative cycles are backhoe, crawler, agricultural tractor, excavator and the typical 1 cycles for welder, wheel loader and skid steer loader. Means for the 7 cycles are computed along with

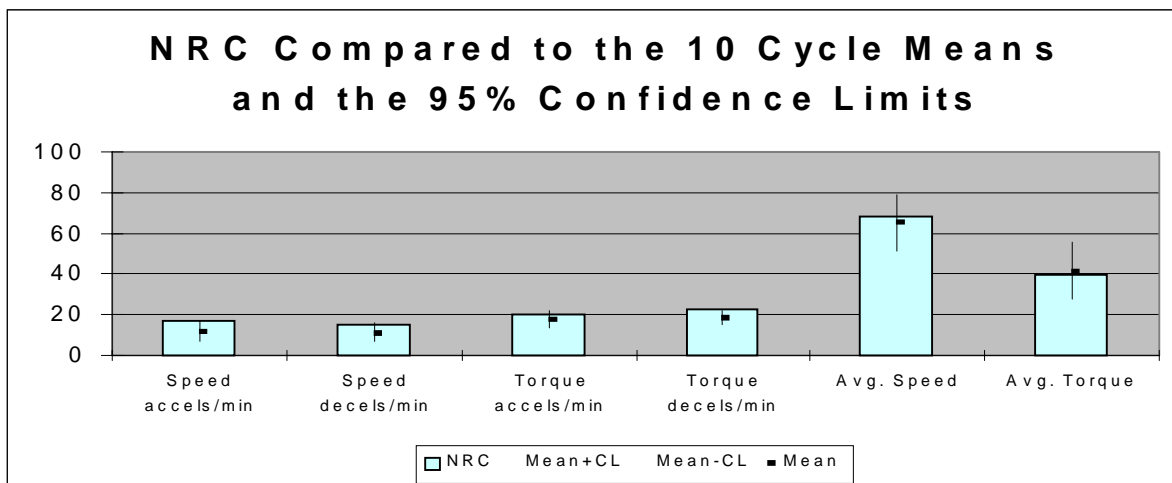
the 95 per cent confidence limits. The below chart presents the results. Appendix U.1 presents more detailed information comparing the 7 cycles along with the composite NRC.



B. NRC Compared

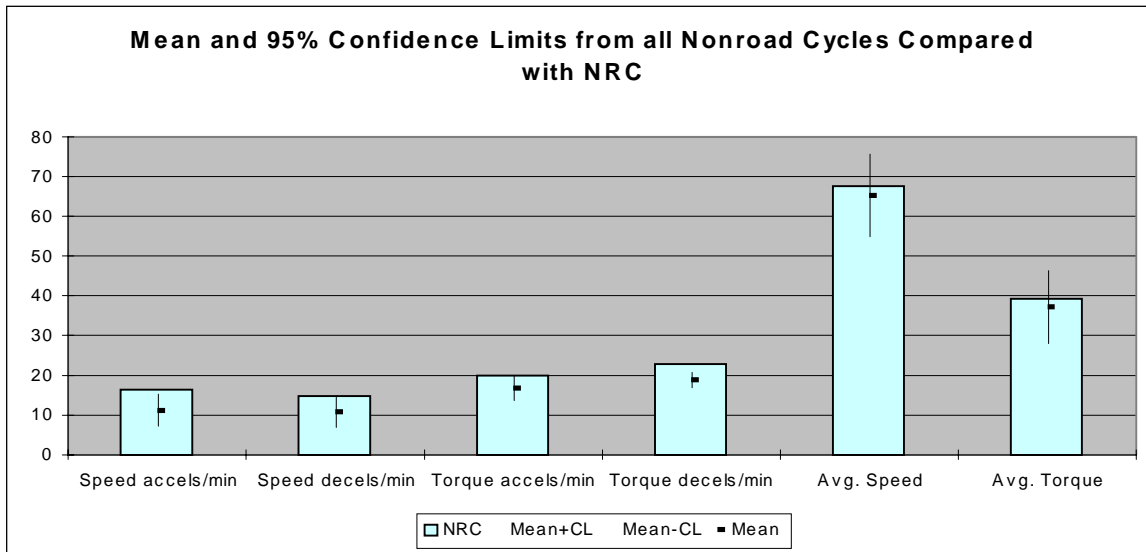
#### *Comparison with 10 Typical and High Torque Nonroad Cycles*

The 10 nonroad cycles are backhoe; crawler; agricultural tractor; typical 1 cycles for wheel loader and skid steer loader; welder typical 2; and high torque transient cycles for welder, wheel loader and skid steer loader. Means for the 10 cycles are computed along with the 95 per cent confidence limits. The below chart presents the results. Appendix U.2 presents more detailed information comparing the 10 cycles along with the composite NRC.



C. *NRC Comparison with all 16 Nonroad Cycles*

The 16 nonroad cycles are backhoe; crawler; agricultural tractor; excavator and typical 1, typical 2, high speed transient and high torque transient cycles for welder, wheel loader and skid steer loader. Means for the 16 cycles are computed along with the 95 per cent confidence limits. The below chart presents the results. Appendix U.3 presents more detailed information comparing the 16 cycles along with the composite NRC.



VII. **References**

- [1].Swain, D., Jackson, C., Lindhjem, C., and Hoffman, G., "A Method for Comparing Transient NOx Emissions with Weighted Steady State Test Results," SAE-980408
- [2].Webb, C., "Nonroad Data Analysis and Cycle Generation," Southwest Research Institute, 08-5374-022, September, 1995.
- [3].Webb, C., "Nonroad Data Analysis and Composite Cycle Development," Southwest Research Institute, 08-7633-818, September, 1997.
- [4].Starr, M., "Nonroad Test Cycle Development," Southwest Research Institute, 08-7633-829, September, 1998.



## VIII. Appendices

### A.1 *Small bin SAS Programs--Example using Backhoe*

#### 1. ba1.sas, Computing Overall Results

```
/******  
*****/  
filename cntin 'd:\backhoe.txt'; * input backhoe data;  
  
title '***** BACKHOE *****',  
  
options nocenter;  
  
%let tpe n;  
%let vars cnt;  
%include 'd:\comp.sas';  
  
run;  
  
/******/  
%let tpe mean;  
%let vars dsp;  
%include 'd:\comp.sas';  
  
run;  
  
/******/  
%let tpe mean;  
%let vars dtor;  
%include 'd:\comp.sas';  
  
run;
```

## 2. comp.sas, Include File for ba1.sas

```
/******  
*****/  
  
data datin;  
  infile cntin firstobs=3; * Observations start at line 3;  
  input cnt speed torque;  
  dsp=speed-lag(speed);  
  dtor=torque-lag(torque);  
  speed2=speed/5;  
  torque2=torque/5;  
  sp=ceil(speed2);  
  tor=ceil(torque2);  
  
proc summary data=datin nway;  
  class sp tor;  
  var &vars;  
  output out=cnts &tpe=;  
  
data cnts1;  
  do sp=0 to 20;  
  do tor=0 to 20;  
  output;  
  end ; end;  
  
proc sort data=cnts; by sp tor;  
proc sort data=cnts1; by sp tor;  
data cnts2;  
  merge cnts cnts1; by sp tor;  
  if &vars =. then &vars = 0;  
  
proc sort data=cnts2; by sp tor;  
proc transpose data=cnts2 out=outcnts prefix=tor; by sp;  
  var &vars;  
  id tor;  
  
data outcnts2(drop= _name_);  
  set outcnts;  
  
proc sort data=outcnts2; by descending sp;  
  
proc print data=outcnts2 noobs;  
  var sp tor0--tor20 ;  
  format tor0--tor20 4.1; ;  
  title2 &tpe ;  
  title3 &vars ;  
  
run;
```

### 3. ba2.sas, Computing Statistics for Speed Changes

```
/******  
*****/  
filename cntin 'd:\backhoe.txt';  
  
title '***** BACKHOE, speed *****';  
  
option nocenter;  
  
data acc cruise dec;  
    infile cntin firstobs=4;  
    input cnt speed torque;  
    dsp=speed-lag(speed);  
    dtor=torque-lag(torque);  
    speed2=speed/5;  
    torque2=torque/5;  
    sp=ceil(speed2);  
    tor=ceil(torque2);  
    if dsp ge 2 then output acc;  
    else if dsp le -2 then output dec;  
    else output cruise;  
  
title2 'Acceleration';  
title3 'Count';  
%let tpe n;  
%let vars cnt;  
%let dspeed acc;  
%include 'd:\comp2.sas';  
run;  
  
title3 'Sum';  
%let tpe sum;  
%let vars dsp;  
%include 'd:\comp2.sas';  
run;  
  
title3 'Mean';  
%let tpe mean;  
%let vars dsp;  
%include 'd:\comp2.sas';  
run;  
  
title3 'Standard Deviation';  
%let tpe std;  
%let vars dsp;  
%include 'd:\comp2.sas';  
run;  
  
/******  
title2 'Deceleration';  
title3 'Count';
```

```

%let tpe n;
%let vars cnt;
%let dspeed dec;
%include 'd:\comp2.sas';
run;

title3 'Sum';
%let tpe sum;
%let vars dsp;
%include 'd:\comp2.sas';
run;

title3 'Mean';
%let tpe mean;
%let vars dsp;
%include 'd:\comp2.sas';
run;

title3 'Standard Deviation';
%let tpe std;
%let vars dsp;
%include 'd:\comp2.sas';
run;

/*****/

title2 'Steady State';
title3 'Count';
%let tpe n;
%let vars cnt;
%let dspeed cruise;
%include 'd:\comp2.sas';
run;

title3 'Sum';
%let tpe sum;
%let vars dsp;
%include 'd:\comp2.sas';
run;

title3 'Mean';
%let tpe mean;
%let vars dsp;
%include 'd:\comp2.sas';
run;

title3 'Standard Deviation';
%let tpe std;
%let vars dsp;
%include 'd:\comp2.sas';
run;

```

#### 4. comp2.sas, Include File for ba2.sas

```
/******  
*****/  
  
proc summary data=&dspeed nway;  
  class sp tor;  
  var &vars;  
  output out=cnts &tpe=;  
  
data cnts1;  
  do sp=0 to 20;  
  do tor=0 to 20;  
  output;  
  end ; end;  
  
proc sort data=cnts; by sp tor;  
proc sort data=cnts1; by sp tor;  
data cnts2;  
  merge cnts cnts1; by sp tor;  
  if &vars =. then &vars = 0;  
  
proc sort data=cnts2; by sp tor;  
proc transpose data=cnts2 out=outcnts prefix=tor; by sp;  
  var &vars;  
  id tor;  
  
data outcnts2(drop= _name_);  
  set outcnts;  
  retain tsums 0;  
  
proc sort data=outcnts2; by descending sp;  
  
proc print data=outcnts2 noobs;  
  var sp tor0--tor20 ;  
  format tor0--tor20 4.1;  
  
run;
```

## 5. bat2.sas, Computing Statistics for Torque Changes

```
/******  
*****/  
filename cntin 'd:\backhoe.txt';  
  
title '***** BACKHOE, torque *****',  
  
option nocenter;  
  
data acc cruise dec;  
    infile cntin firstobs=4;  
    input cnt speed torque;  
    dsp=speed-lag(speed);  
    dtor=torque-lag(torque);  
    speed2=speed/5;  
    torque2=torque/5;  
    sp=ceil(speed2);  
    tor=ceil(torque2);  
    if dtor ge 2 then output acc;  
    else if dtor le -2 then output dec;  
    else output cruise;  
  
title2 'Acceleration';  
title3 'Count';  
%let tpe n;  
%let vars cnt;  
%let dspeed acc;  
%include 'd:\compt2.sas';  
  
title3 'Sum';  
%let tpe sum;  
%let vars dtor;  
%include 'd:\compt2.sas';  
  
title3 'Mean';  
%let tpe mean;  
%let vars dtor;  
%include 'd:\compt2.sas';  
  
title3 'Standard Deviation';  
%let tpe std;  
%let vars dtor;  
%include 'd:\compt2.sas';  
run;  
  
/******/  
title2 'Deceleration';  
title3 'Count';  
%let tpe n;  
%let vars cnt;  
%let dspeed dec;  
%include 'd:\compt2.sas';  
  
title3 'Sum';  
%let tpe sum;
```

```
%let vars dtor;  
%include 'd:\compt2.sas';
```

```
title3 'Mean';  
%let tpe mean;  
%let vars dtor;  
%include 'd:\compt2.sas';
```

```
title3 'Standard Deviation';  
%let tpe std;  
%let vars dtor;  
%include 'd:\compt2.sas';
```

```
run;  
/*****/
```

```
title2 'Steady State';  
title3 'Count';  
%let tpe n;  
%let vars cnt;  
%let dspeed cruise;  
%include 'd:\compt2.sas';
```

```
title3 'Sum';  
%let tpe sum;  
%let vars dtor;  
%include 'd:\compt2.sas';
```

```
title3 'Mean';  
%let tpe mean;  
%let vars dtor;  
%include 'd:\compt2.sas';
```

```
title3 'Standard Deviation';  
%let tpe std;  
%let vars dtor;  
%include 'd:\compt2.sas';
```

```
run;  
/*****/
```

6. compt2.sas, Include File for bat2.sas

```
/******  
*****/  
  
proc summary data=&dspeed nway;  
  class sp tor;  
  var &vars;  
  output out=cnts &tpe=;  
  
data cnts1;  
  do sp=0 to 20;  
  do tor=0 to 20;  
  output;  
  end ; end;  
  
proc sort data=cnts; by sp tor;  
proc sort data=cnts1; by sp tor;  
data cnts2;  
  merge cnts cnts1; by sp tor;  
  if &vars =. then &vars = 0;  
  
proc sort data=cnts2; by sp tor;  
proc transpose data=cnts2 out=outcnts prefix=tor; by sp;  
  var &vars;  
  id tor;  
  
data outcnts2(drop= _name_);  
  set outcnts;  
  
proc sort data=outcnts2; by descending sp;  
  
proc print data=outcnts2 noobs;  
  var sp tor0--tor20 ;  
  format tor0--tor20 4.1;  
  
run;
```



## A.2 Big bin SAS Programs--Example using Backhoe

### 1. compare.sas, Produce Tabular Output

```
*****
*****/
filename cntin 'c:\backhoe.txt'; * input data;

title '***** Backhoe *****';

options nocenter;

proc format;
    value sptor 0='Idle'
              1='Low'
              2='Medium'
              3='Intermediate'
              4='High';

data datin;
    infile cntin firstobs=2;
    retain spsum 0 torsum 0;
    input sec sp tor ;
    spsum=spsum+sp;
    torsum=torsum+tor;
    dsp=sp-lag(sp);
    dtor=tor-lag(tor);
    if sp gt 75 then speed=4;
    else if sp gt 60 then speed=3;
    else if sp gt 40 then speed=2;
    else speed=1;

    if tor gt 75 then torque=4;
    else if tor gt 60 then torque=3;
    else if tor gt 40 then torque=2;
    else torque=1;

    if sp le 10 and tor le 10 then do;
        speed=0; torque=0;
    end;

    format speed torque sptor.;

data acc cruise dec;
    set datin;
    if dsp ge 2 then output acc;
    else if dsp le -2 then output dec;
    else output cruise;

title2 '***** Speed Accelerations *****';

proc tabulate data=acc format=5.;
```

```

var dsp;
class speed torque;
table speed, torque* n=' '*dsp=' ';
title3 'Counts';

proc tabulate data=acc format=5.2;
var dsp;
class speed torque;
table speed, torque* mean=' '*dsp=' ';
title3 'Mean speed changes with time';

proc tabulate data=acc format=5.2;
var dtor;
class speed torque;
table speed, torque* mean=' '*dtor=' ';
title3 'Mean torque changes with time';

/***** Now to work on Torque *****/

data acc cruise dec;
set datin;
if dtor ge 2 then output acc;
else if dtor le -2 then output dec;
else output cruise;

title2 '***** Torque Accelerations *****';

proc tabulate data=acc format=5.;
var dsp;
class speed torque;
table speed, torque* n=' '*dsp=' ';
title3 'Counts';

proc tabulate data=acc format=5.2;
var dsp;
class speed torque;
table speed, torque* mean=' '*dsp=' ';
title3 'Mean speed changes with time';

proc tabulate data=acc format=5.2;
var dtor;
class speed torque;
table speed, torque* mean=' '*dtor=' ';
title3 'Mean torque changes with time';

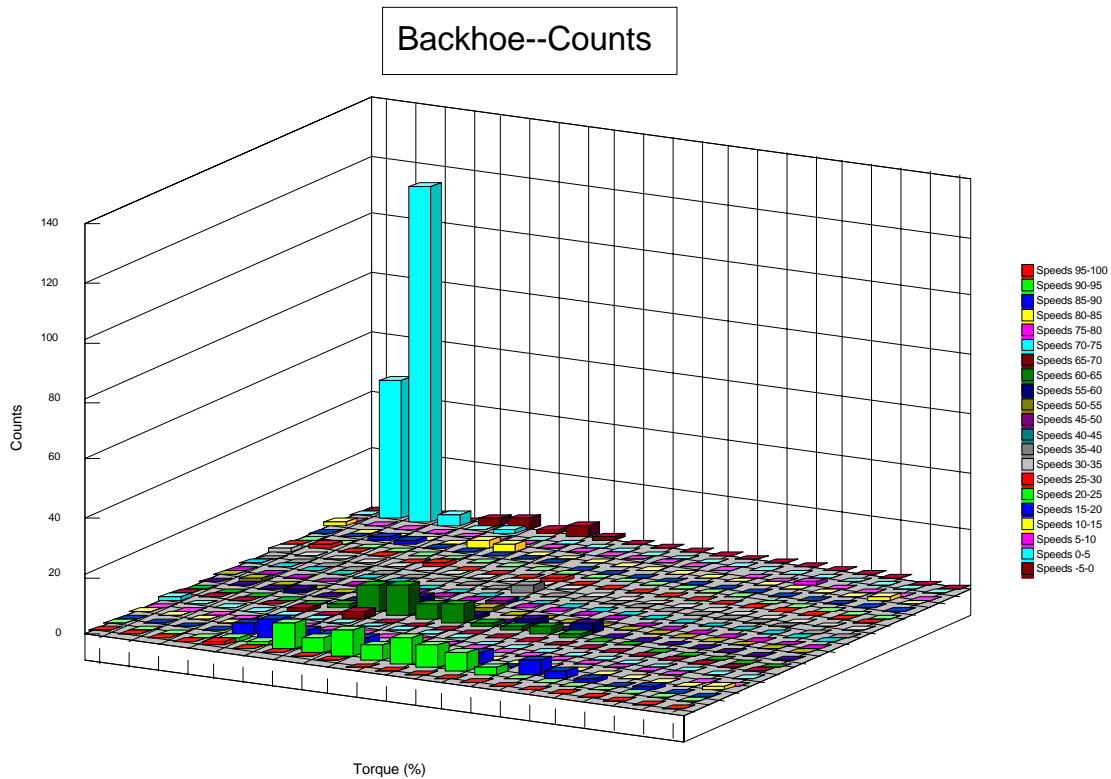
run;

```

## B.1 Lotus Small Bin Spreadsheet Example--Backhoe Overall Counts

### Backhoe--Counts

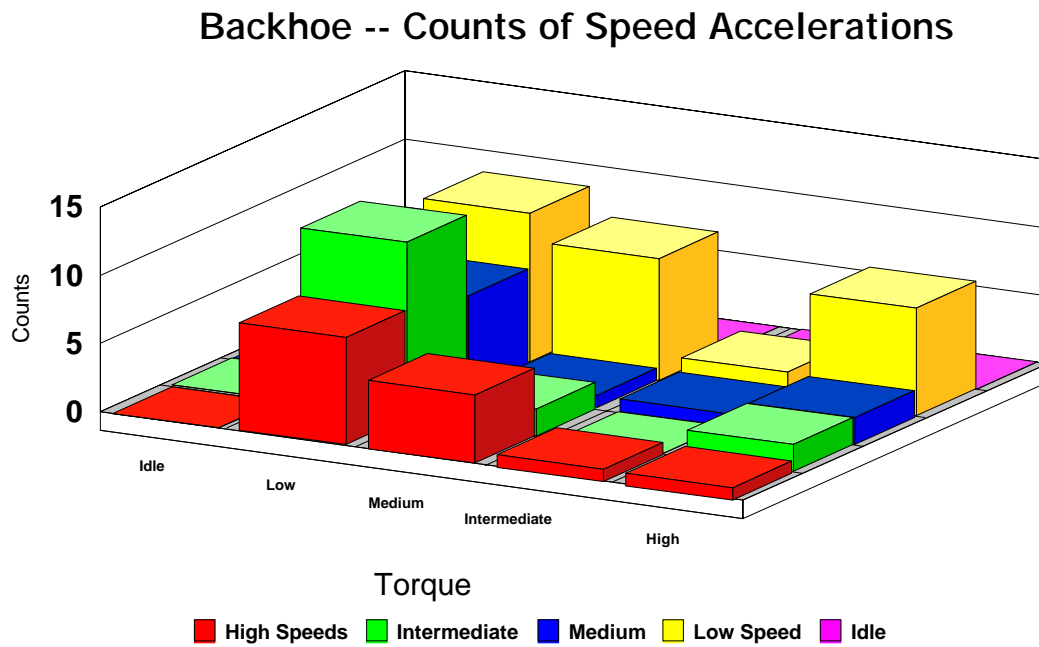
Speeds 95-100	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speeds 90-95	0	0	0	1	2	2	9	6	9	6	10	8	7	3	1	0	1	0	1	0
Speeds 85-90	0	0	0	0	4	7	4	4	4	1	3	0	5	1	6	3	2	1	2	0
Speeds 80-85	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2
Speeds 75-80	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Speeds 70-75	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Speeds 65-70	0	0	1	0	2	0	3	1	1	1	0	0	0	0	0	0	0	0	1	0
Speeds 60-65	0	1	0	0	0	2	9	11	6	7	2	2	3	2	0	0	0	0	0	0
Speeds 55-60	0	0	0	2	1	1	0	4	0	2	0	3	1	5	1	1	1	0	1	0
Speeds 50-55	0	2	0	0	0	0	1	1	0	2	0	1	1	0	0	0	0	0	0	0
Speeds 45-50	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0
Speeds 40-45	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Speeds 35-40	0	0	0	0	1	1	0	0	0	3	1	1	0	0	0	0	0	0	0	0
Speeds 30-35	2	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1
Speeds 25-30	0	2	1	1	0	2	1	0	0	2	0	0	1	0	0	0	0	1	0	0
Speeds 20-25	0	0	1	0	0	0	1	1	0	1	1	0	0	0	0	1	0	0	0	0
Speeds 15-20	1	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speeds 10-15	2	1	1	0	0	3	3	1	0	0	0	0	0	0	0	0	0	0	2	0
Speeds 5-10	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	1
Speeds 0-5	0	48	115	4	0	2	0	1	0	0	0	1	0	0	0	0	0	0	1	0
Speeds -5-0	0	1	2	0	3	5	2	4	2	1	0	0	0	0	1	0	0	0	0	0



## B.2 Lotus Big bin Spreadsheet Example--Backhoe Overall Counts

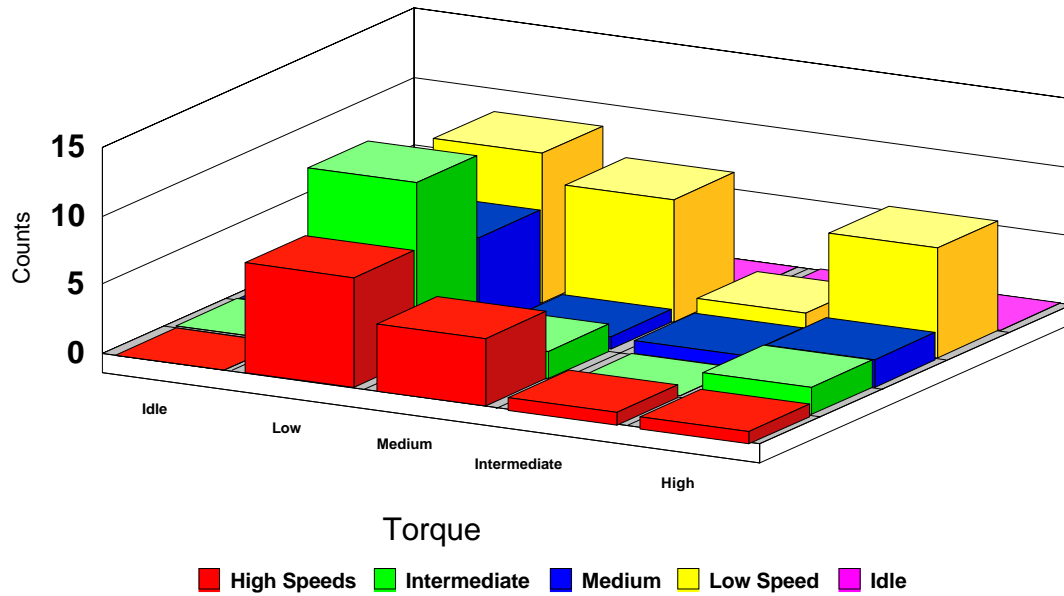
Backhoe- Counts

		Idle	Low	Medium	Intermediate	High
High Speeds	0		8	5	1	1
Intermediate	0		13	2	0	2
Medium	0		7	1	1	2
Low Speed	0		11	9	2	8
Idle	2		0	0	0	0

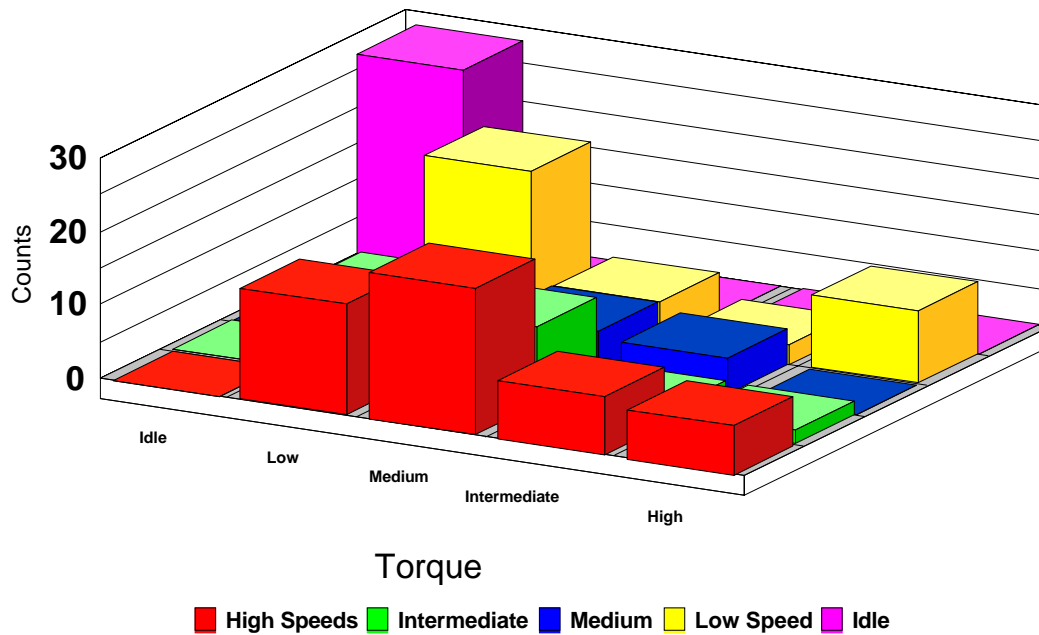


- C.1 *Backhoe Small Bin Charts.* See accompanying file appendixC1.backhoe.wpd.  
 C.2 *Backhoe Big Bin Charts*

### Backhoe -- Counts of Speed Accelerations

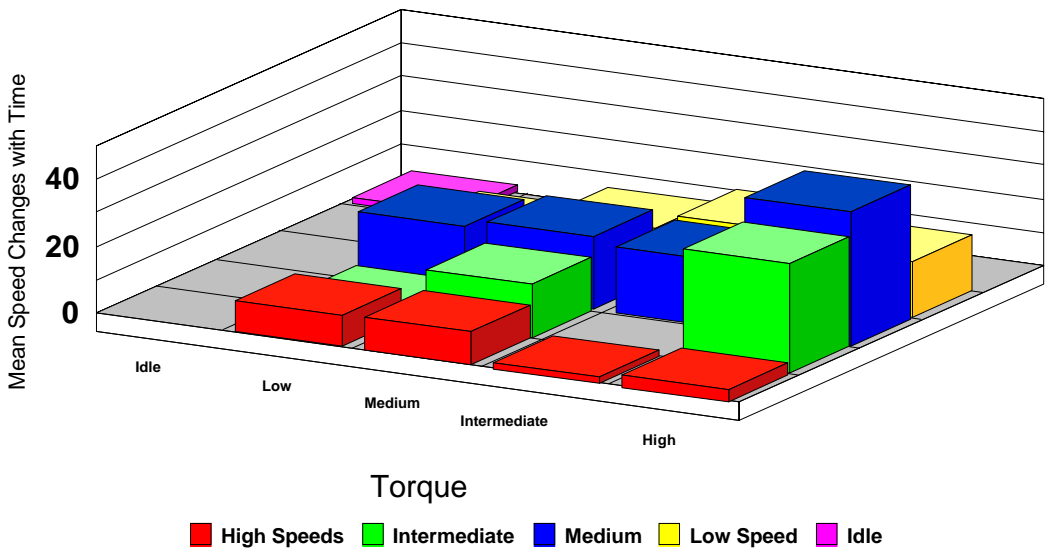


### Backhoe -- Counts of Torque Accelerations



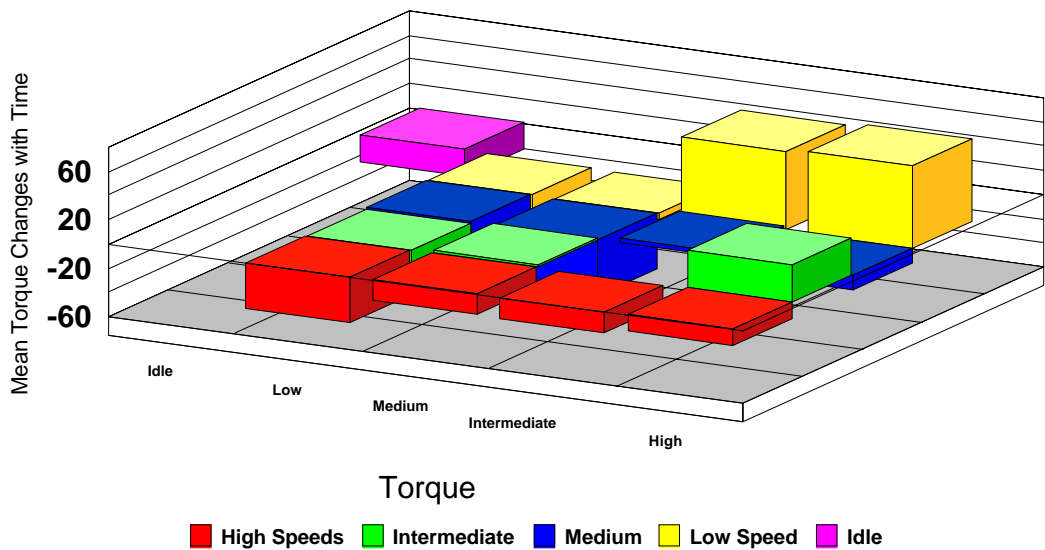
# Backhoe -- Mean Speed Changes with Time

For Speed Accelerations

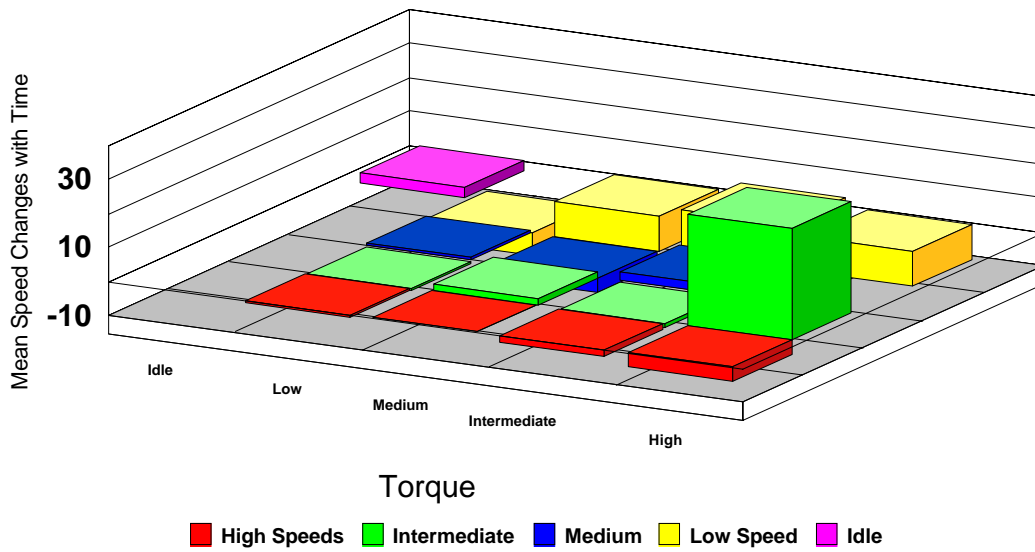


# Backhoe -- Mean Torque Changes with Time

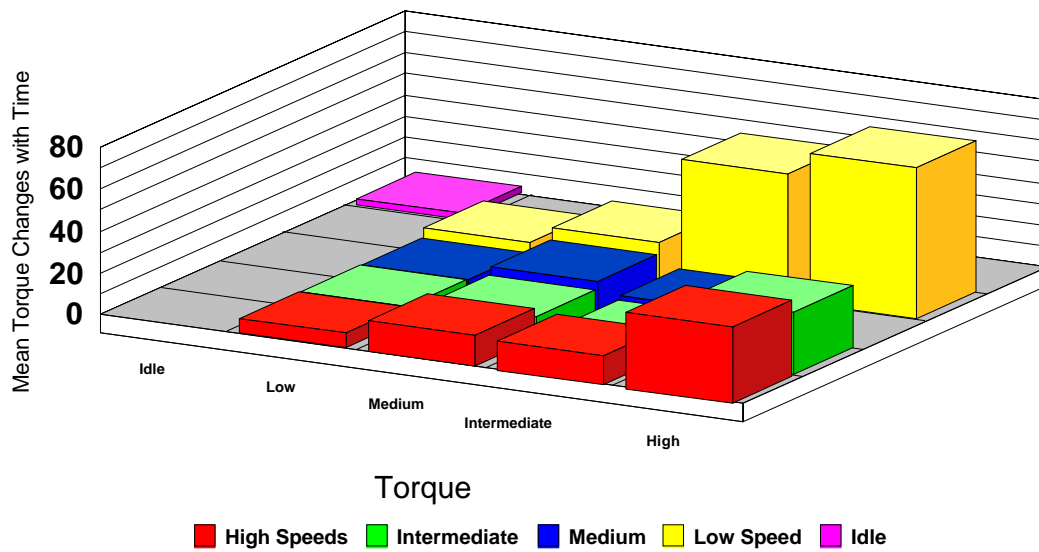
For Speed Accelerations



**Backhoe -- Mean Speed Changes with Time**  
For Torque Accelerations

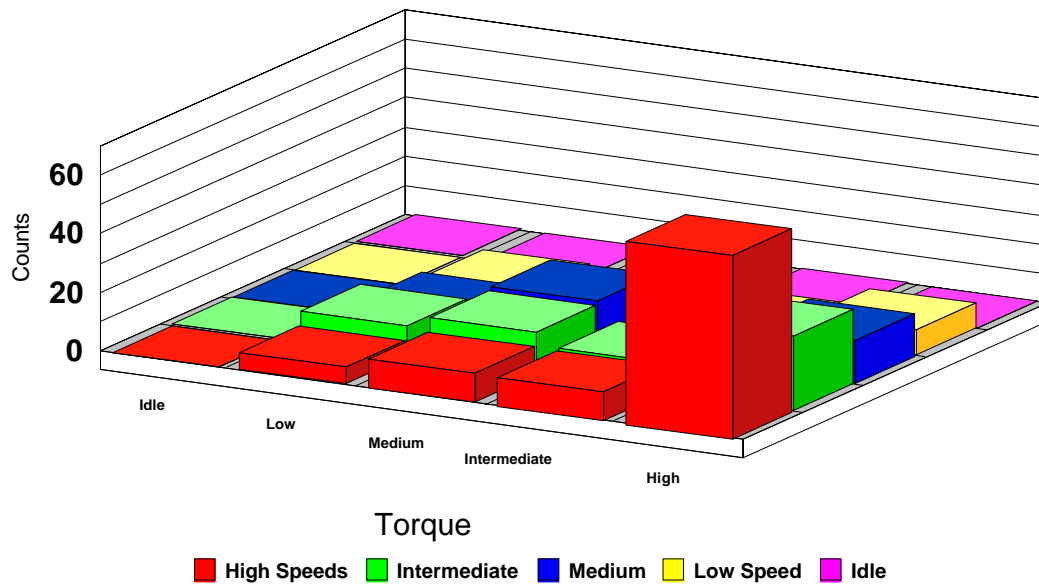


**Backhoe -- Mean Torque Changes with Time**  
For Torque Accelerations

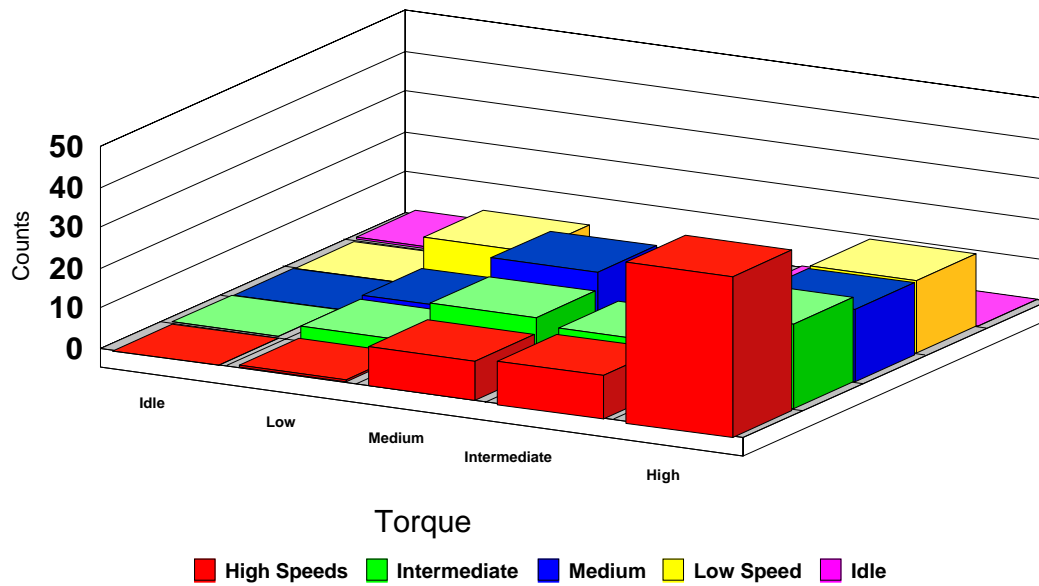


- D.1 Crawler Small Bin Charts. See accompanying file appendixD1\_crawler.wpd.  
D.2 Crawler Big Bin Charts

### Crawler -- Counts of Speed Accelerations

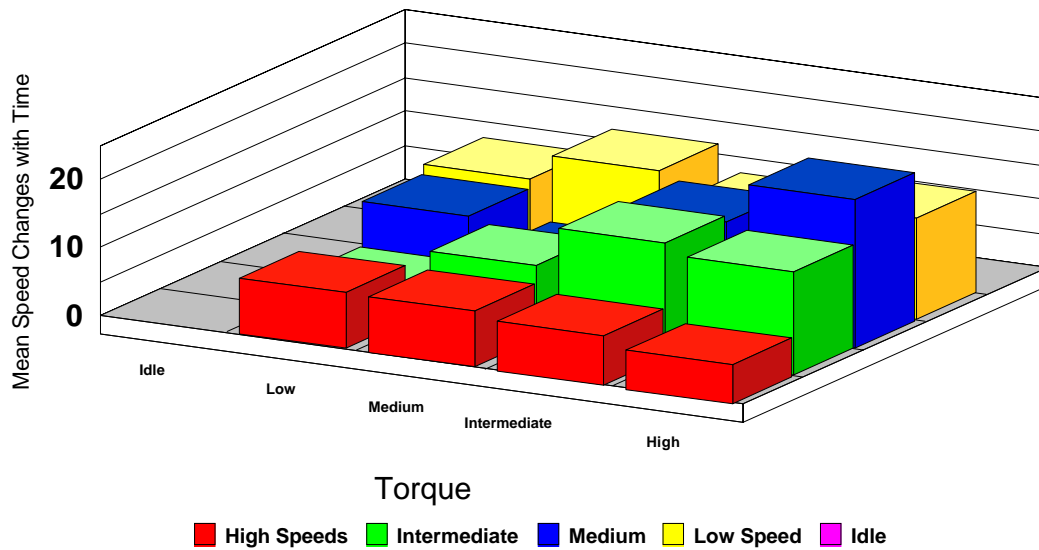


### Crawler -- Counts of Torque Accelerations

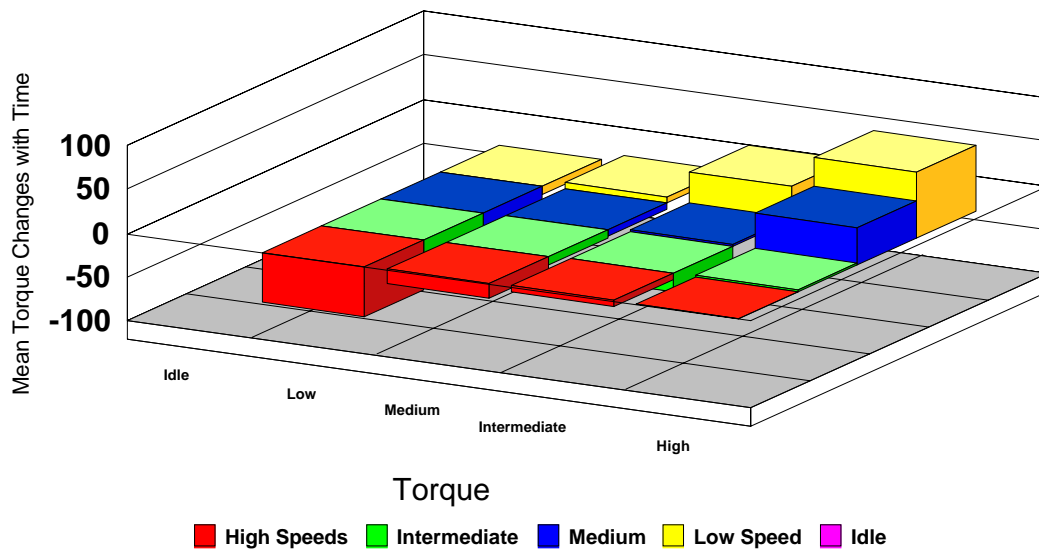




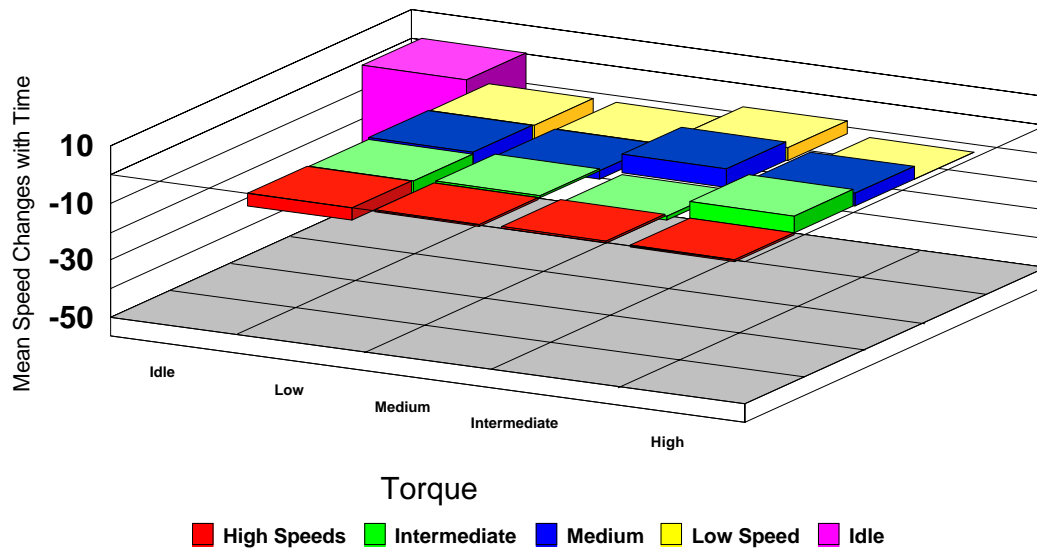
**Crawler -- Mean Speed Changes with Time**  
For Speed Accelerations



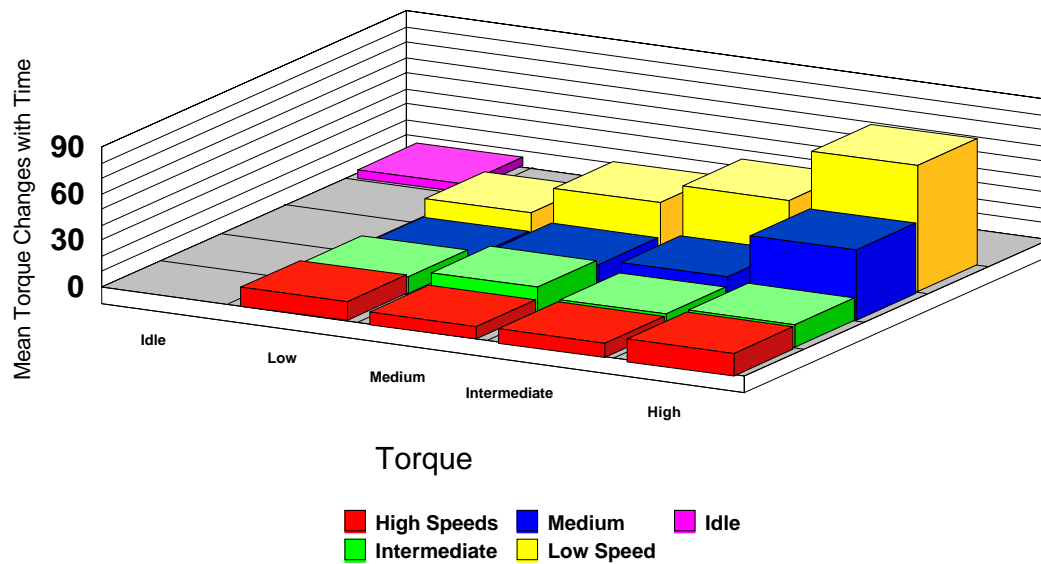
**Crawler -- Mean Torque Changes with Time**  
For Speed Accelerations



Crawler -- Mean Speed Changes with Time  
For Torque Accelerations

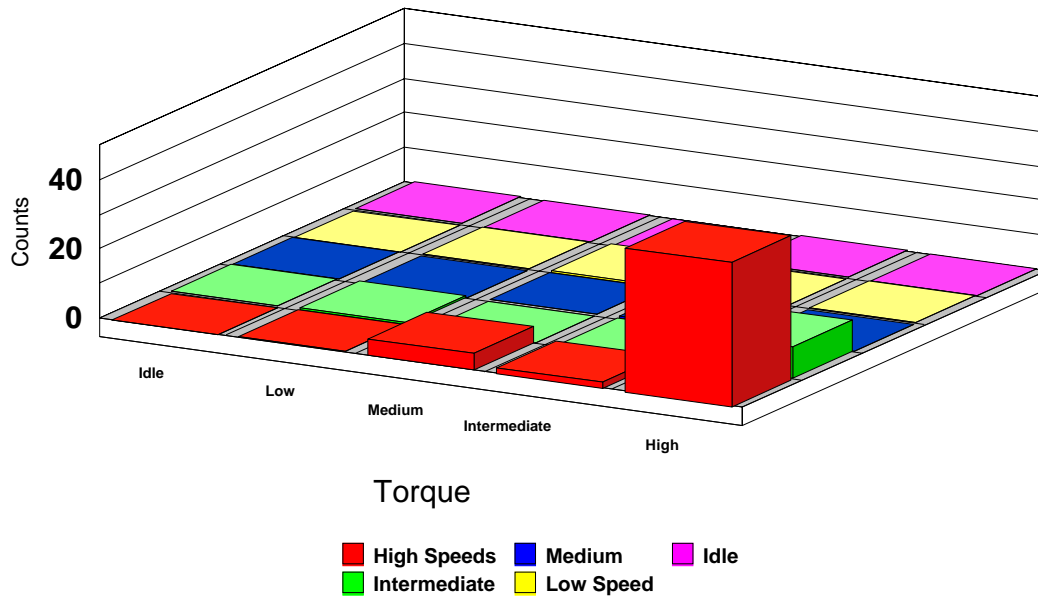


Crawler -- Mean Torque Changes with Time  
For Torque Accelerations

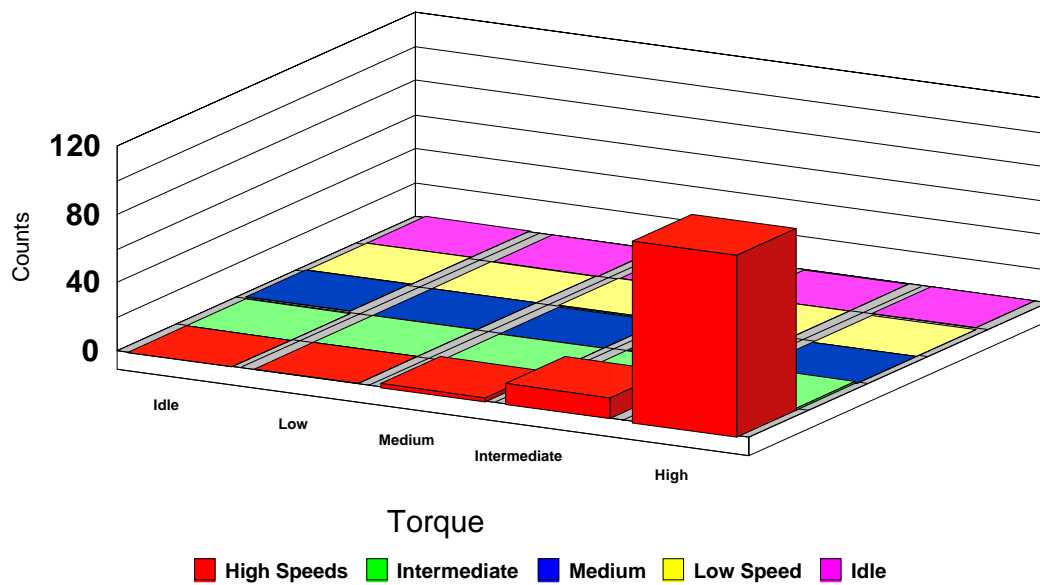


- E.1 *Agricultural Tractor Small Bin Charts.* See accompanying file appendixE1\_agtrac.wpd.  
 E.2 *Agricultural Tractor Big Bin Charts*

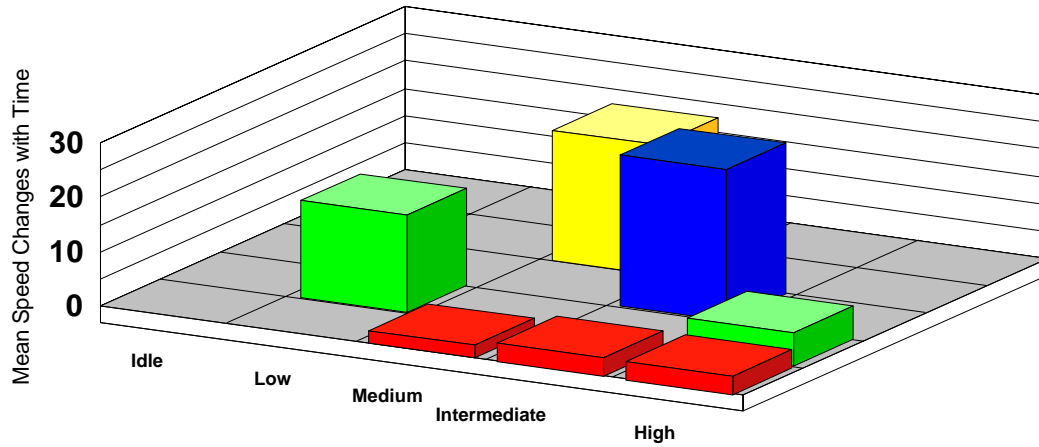
## Agricultural Tractor -- Counts of Speed Accelerations



## Agricultural Tractor -- Counts of Torque Accelerations



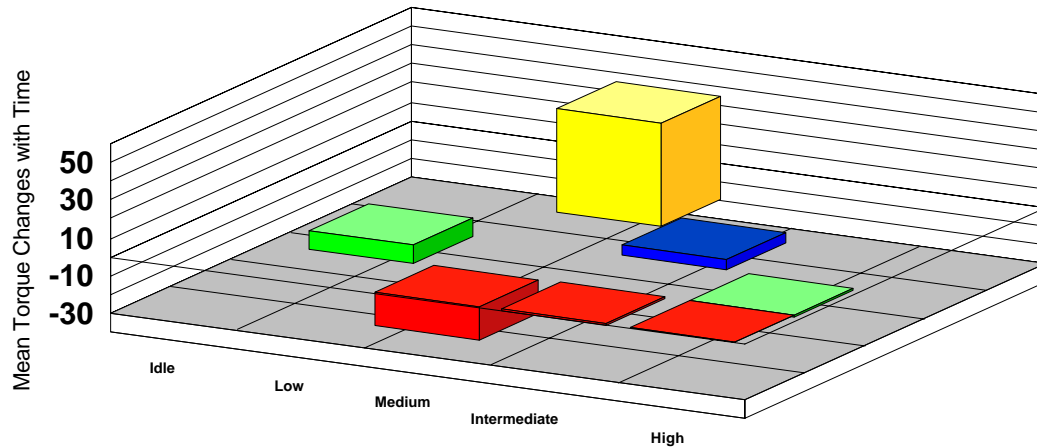
**Agricultural Tractor -- Mean Speed Changes with Time**  
For Speed Accelerations



Torque

■ High Speeds 
 ■ Intermediate 
 ■ Medium 
 ■ Low Speed 
 ■ Idle

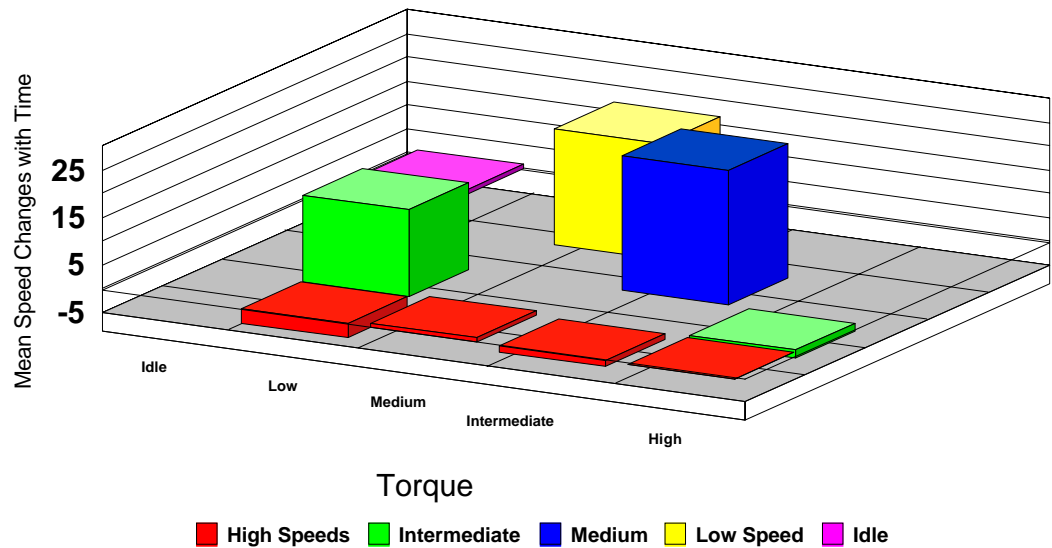
**Agricultural Tractor -- Mean Torque Changes with Time**  
For Speed Accelerations



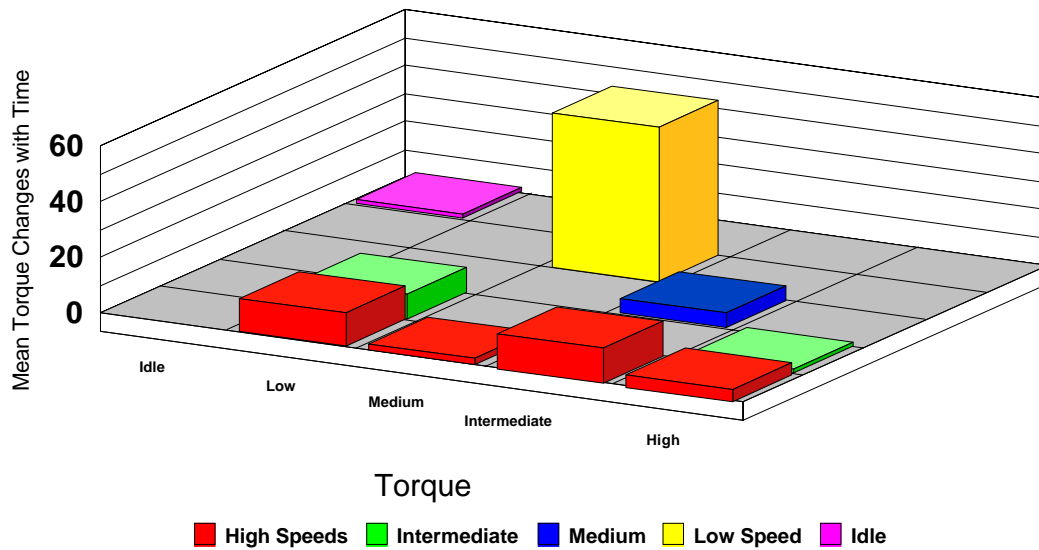
Torque

■ High Speeds 
 ■ Intermediate 
 ■ Medium 
 ■ Low Speed 
 ■ Idle

**Agricultural Tractor -- Mean Speed Changes with Time**  
For Torque Accelerations

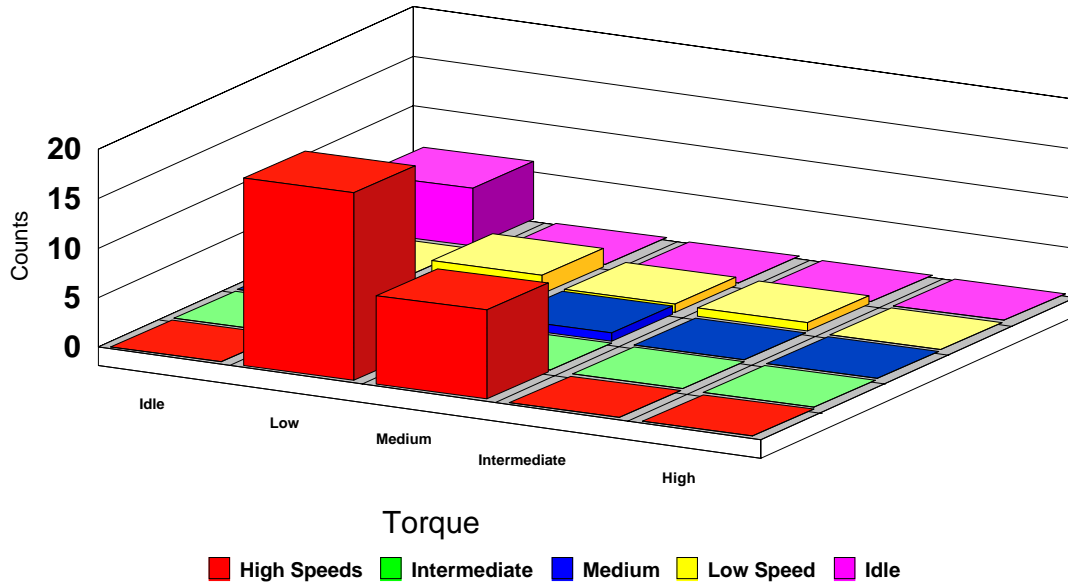


**Agricultural Tractor -- Mean Torque Changes with Time**  
For Torque Accelerations

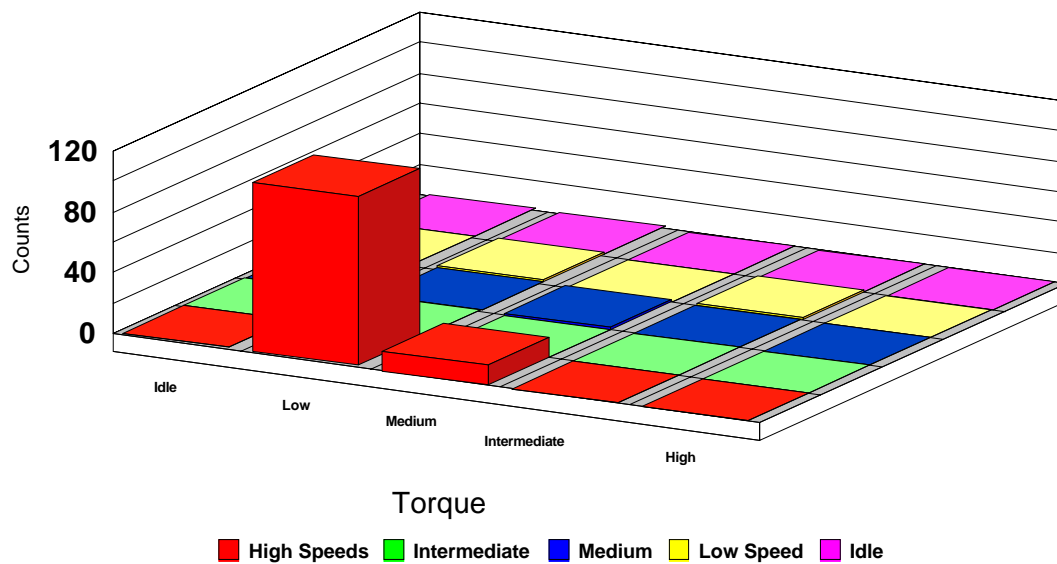


- F.1 Welder--Typical 1 Small Bin Charts. See accompanying file appendixF1\_weldert1.wpd.  
 G.1 Welder--Typical 2 Small Bin Charts. See accompanying file appendixG1\_weldert2.wpd.  
 G.2 Welder--Typical 2 Big Bin Charts

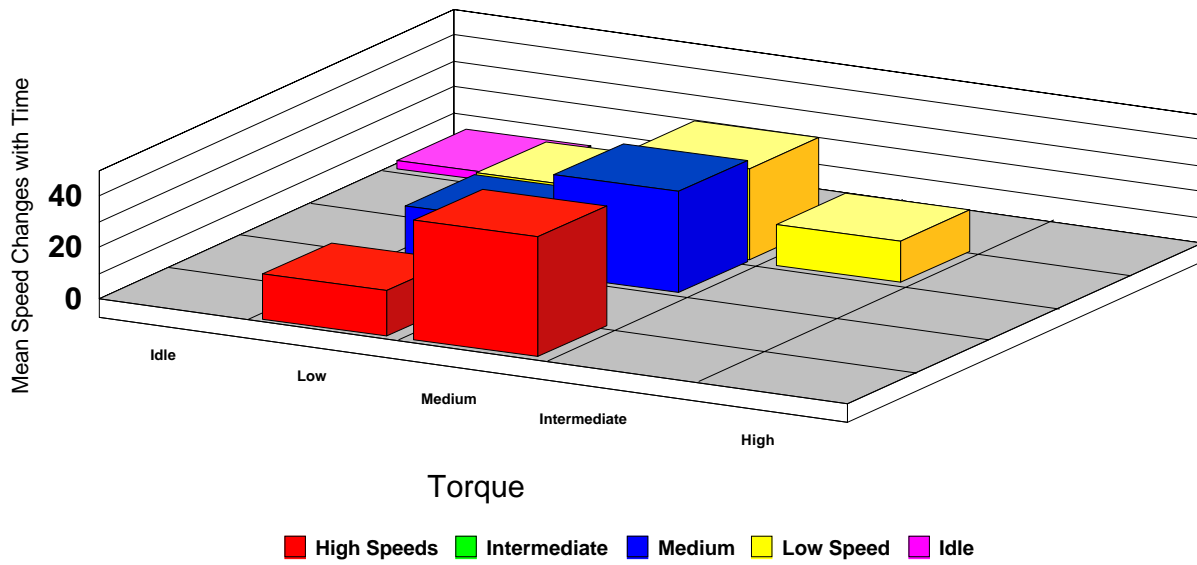
## Arc Welder, Typical 2 -- Counts of Speed Accelerations



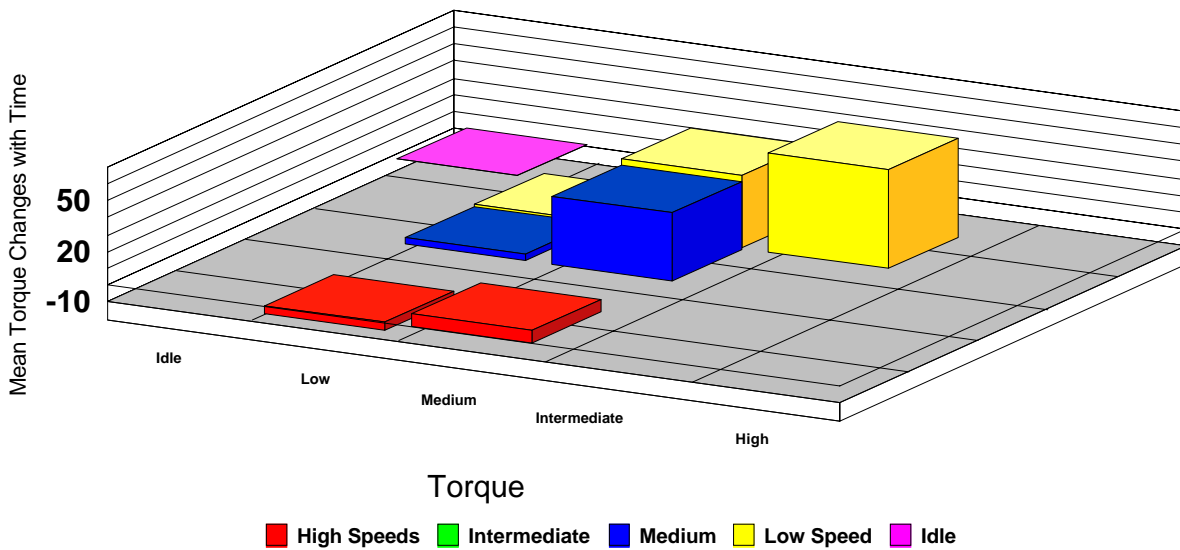
## Arc Welder, Typical 2 -- Counts of Torque Accelerations



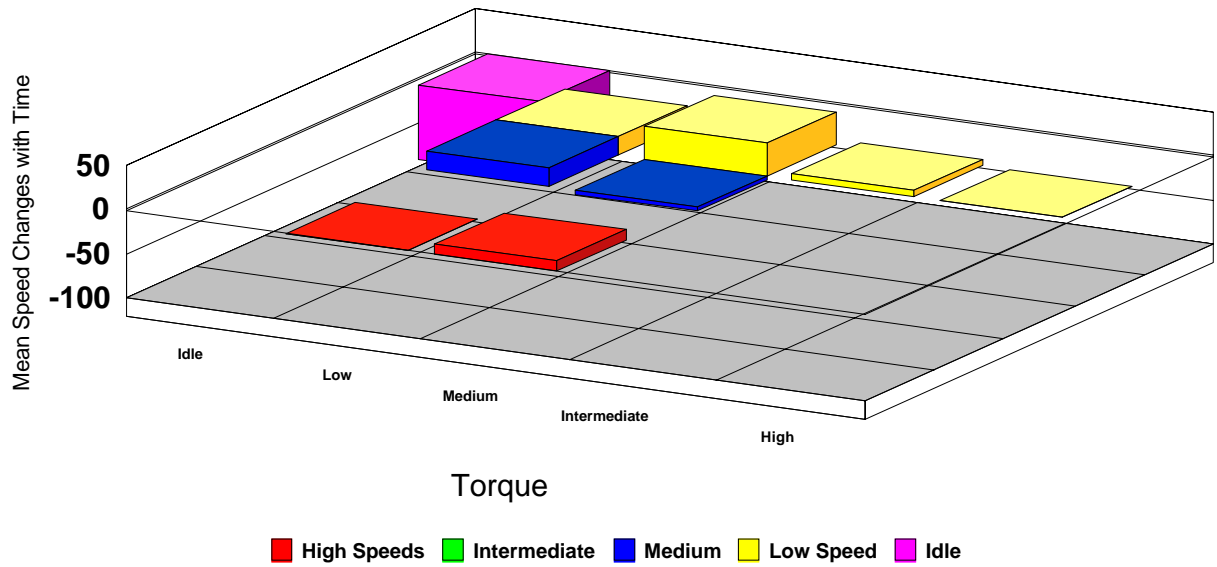
Arc Welder, Typical 2 -- Mean Speed Changes with Time  
For Speed Accelerations



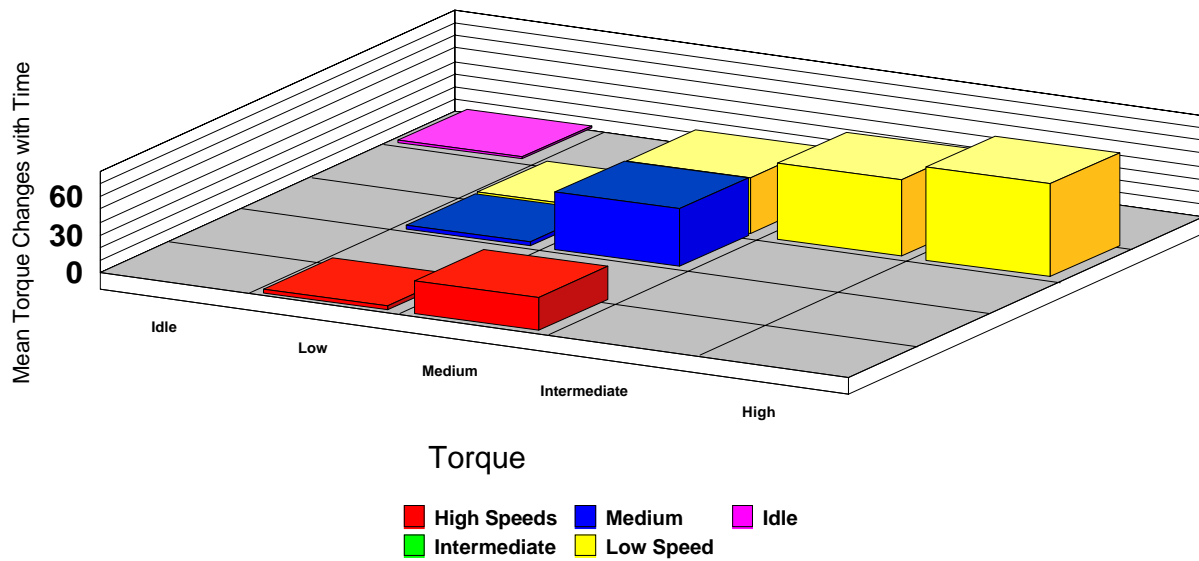
Arc Welder, Typical 2 -- Mean Torque Changes with Time  
For Speed Accelerations



### Arc Welder, Typical 2 -- Mean Speed Changes with Time For Torque Accelerations



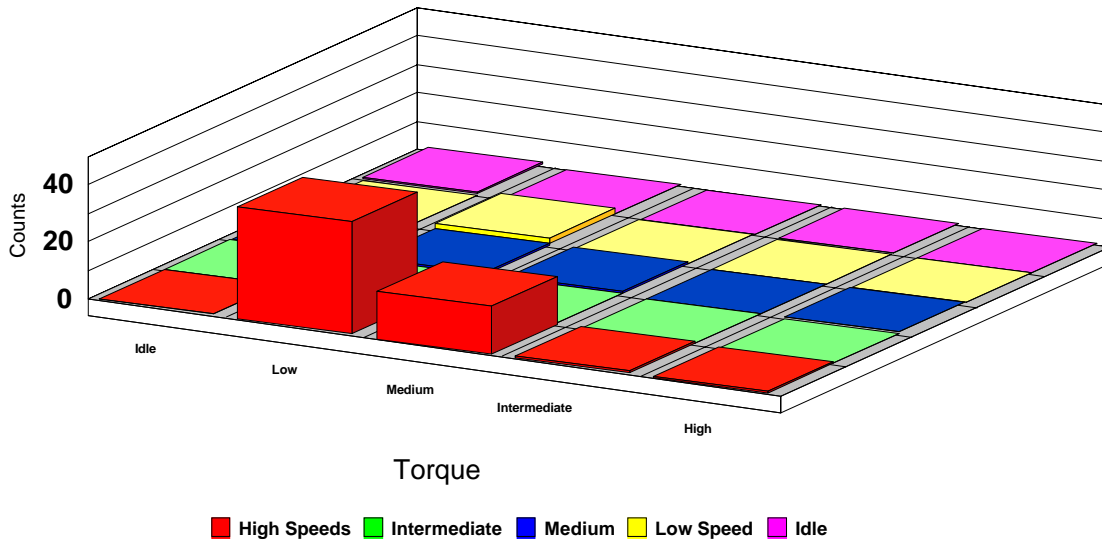
### Arc Welder, Typical 2 -- Mean Torque Changes with Time For Torque Accelerations



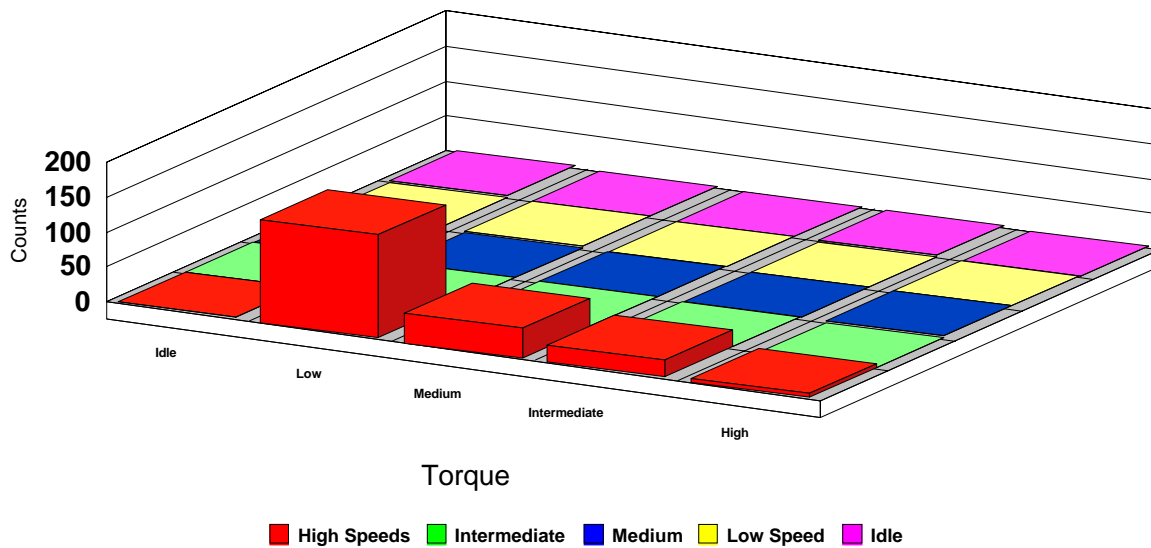


- H.1 *Welder-High Speed Transient Small Bin Charts.* See accompanying file appendixH1\_welderhs.wpd.
- I.1 *Welder-High Torque Transient Small Bin Charts.* See accompanying file appendixI1\_welderht.wpd.
- I.2 *Welder-High Torque Transient Big Bin Charts*

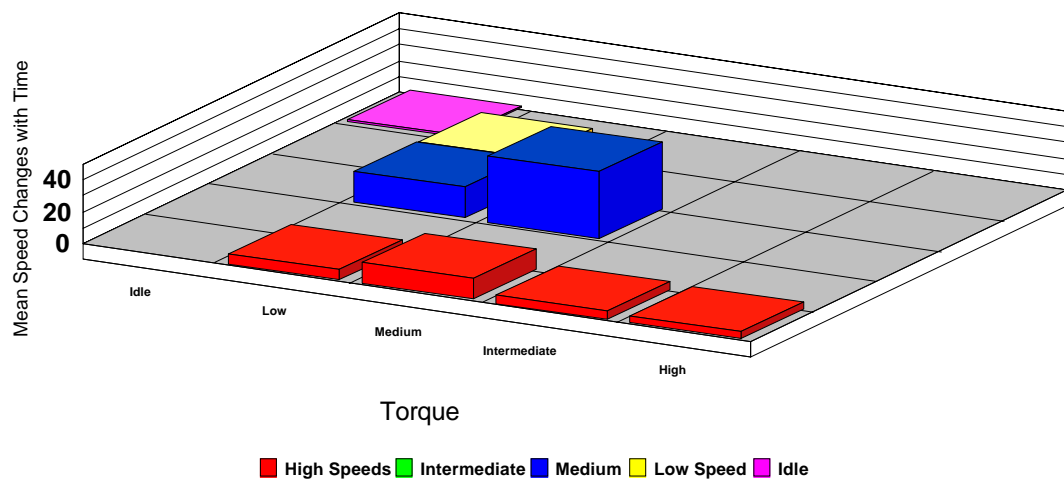
### Arc Welder, High Torque Transient--Counts of Speed Accelerations



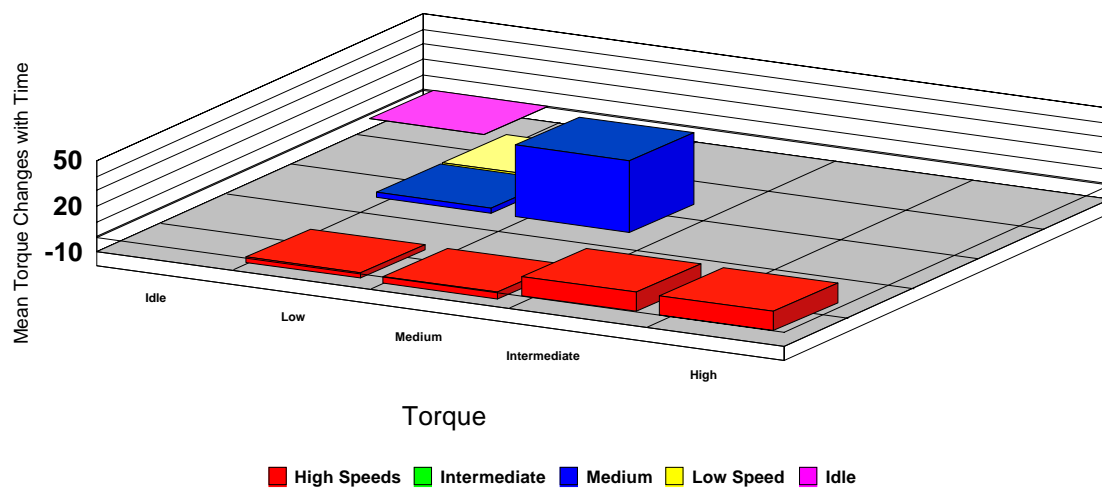
### Arc Welder, High Torque Transient -- Counts of Torque Accelerations



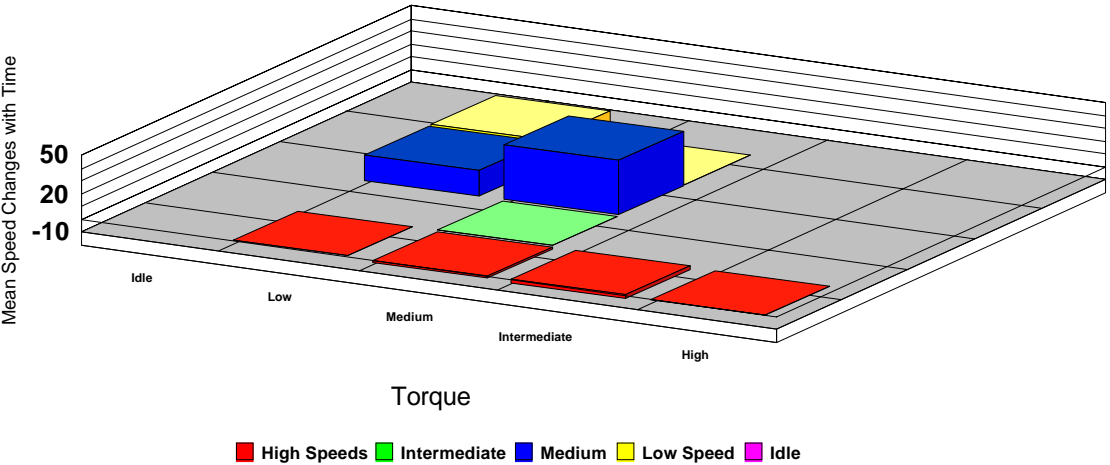
Arc Welder, High Torque Transient -- Mean Speed Changes with Time  
For Speed Accelerations



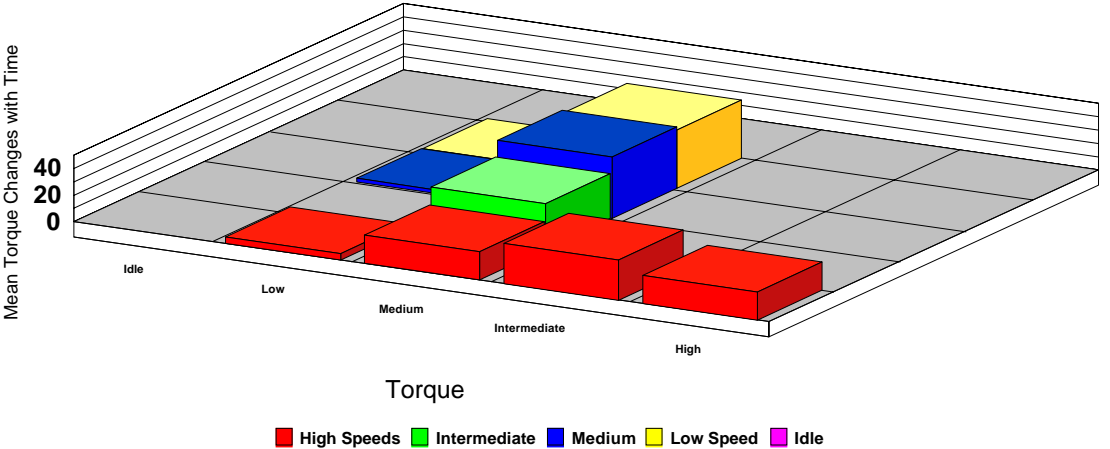
Arc Welder, High Torque Transient -- Mean Torque Changes with Time  
For Speed Accelerations



Arc Welder, High Torque Transient -- Mean Speed Changes with Time  
For Torque Accelerations

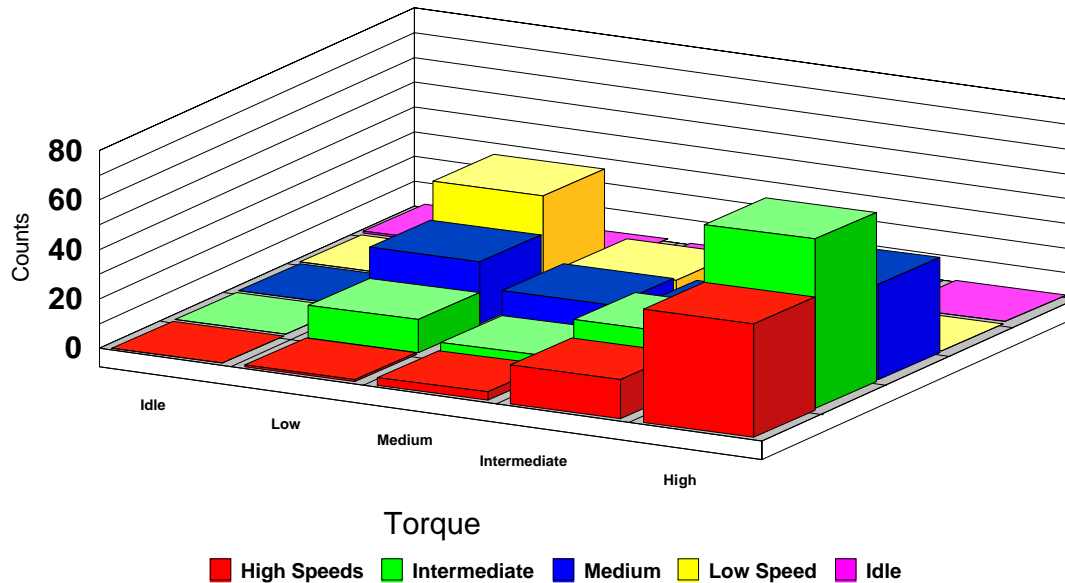


Arc Welder, High Torque Transient -- Mean Torque Changes with Time  
For Torque Accelerations

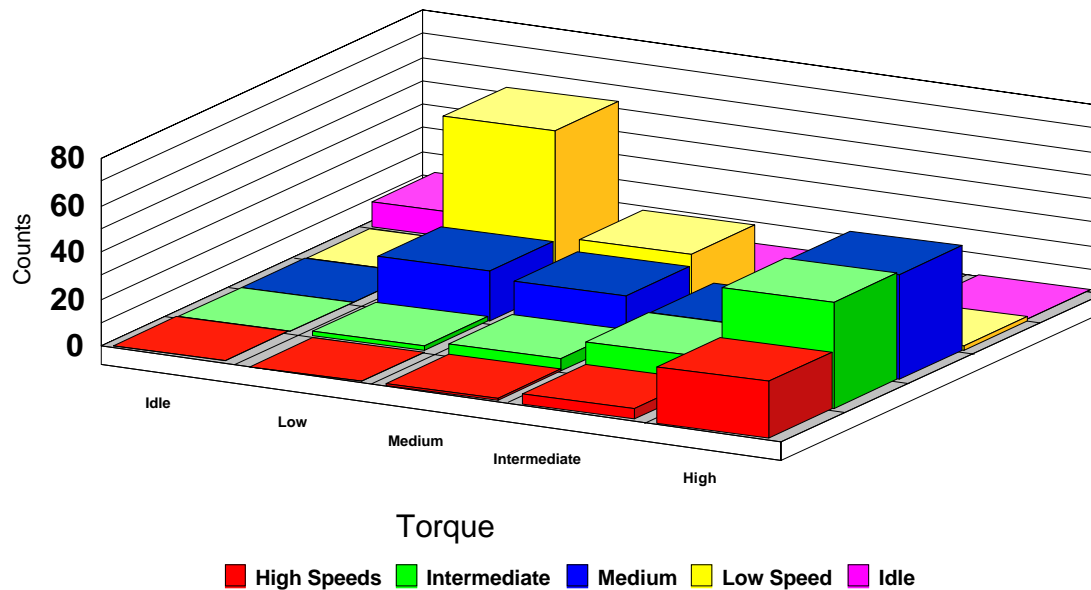


- J.1 *Wheel Loader--Typical 1 Small Bin Charts.* See accompanying file  
 appendixJ1\_wheelloadt1.wpd.
- J.2 *Wheel Loader--Typical 1 Big Bin Charts*

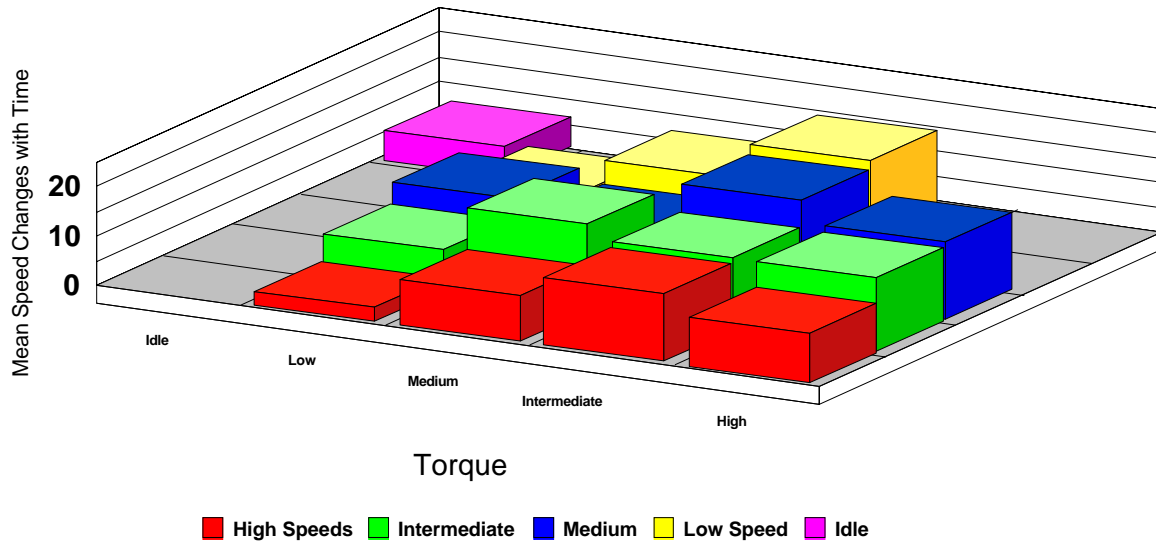
## Wheel Loader, Typical 1 -- Counts of Speed Accelerations



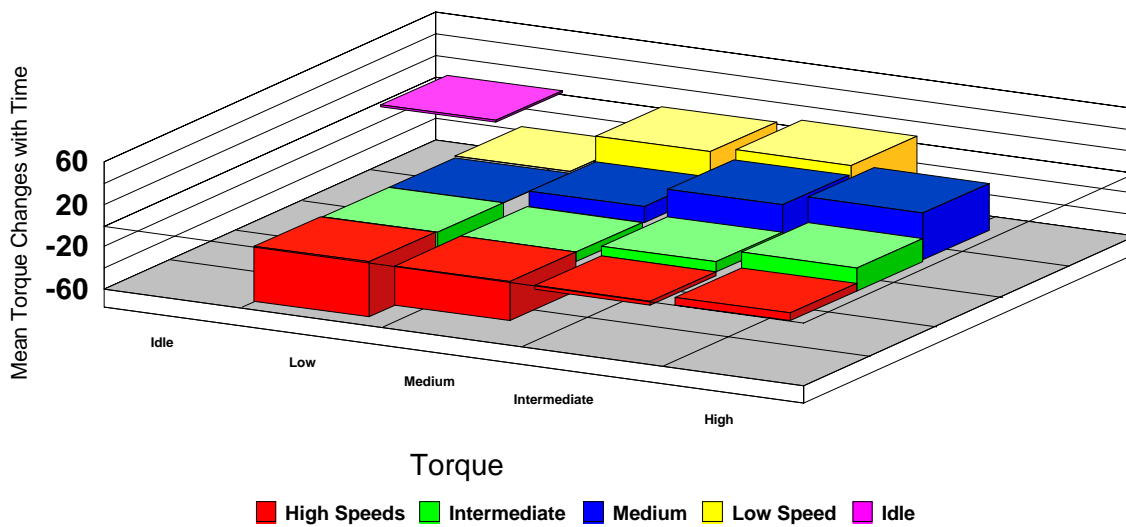
## Wheel Loader, Typical 1 -- Counts of Torque Acceleration:



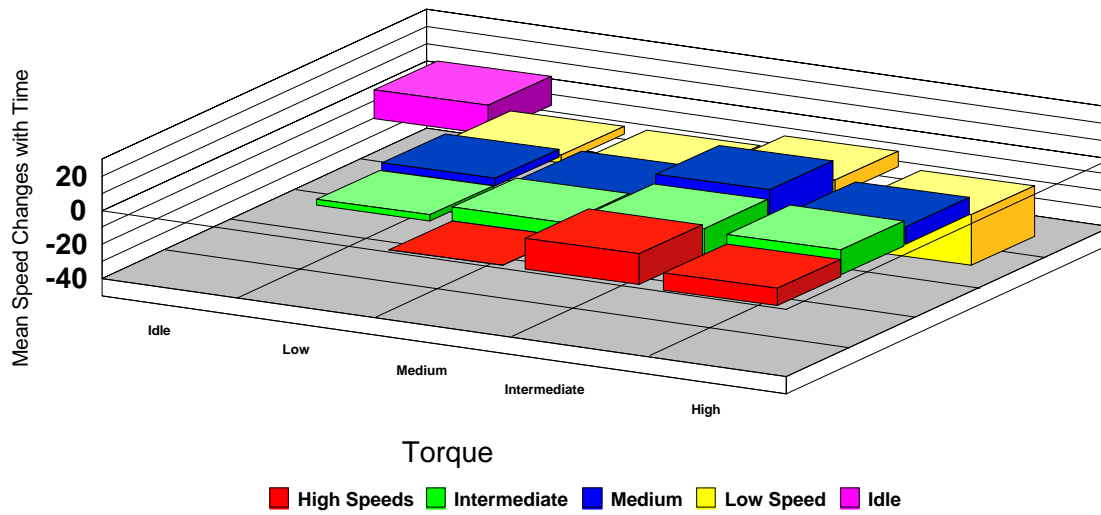
Wheel Loader, Typical 1 -- Mean Speed Changes with Time  
For Speed Accelerations



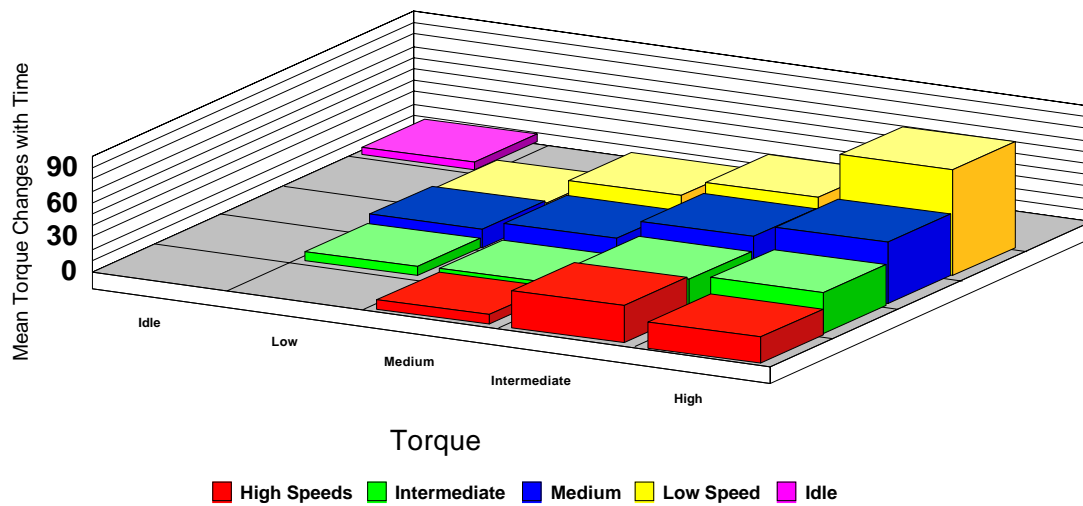
Wheel Loader, Typical 1 -- Mean Torque Changes with Time  
For Speed Accelerations



Wheel Loader, Typical 1 -- Mean Speed Changes with Time  
For Torque Accelerations

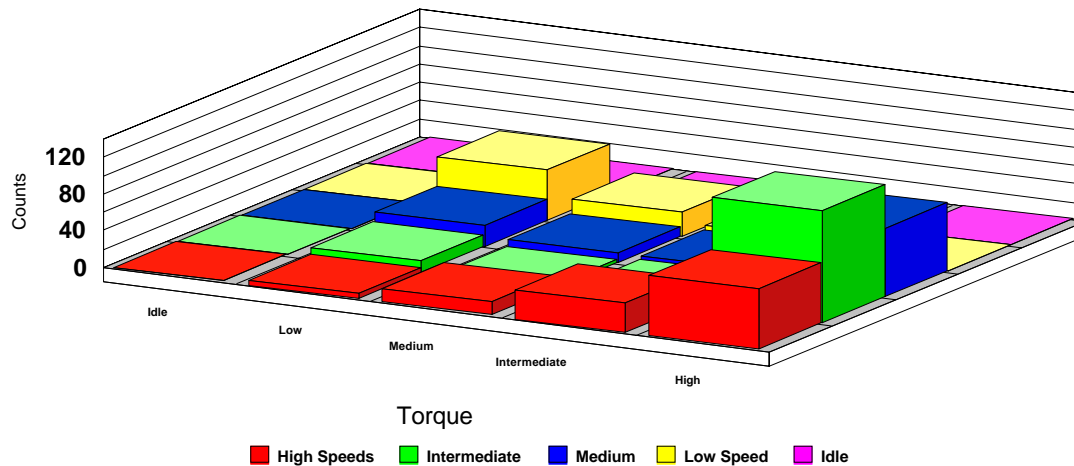


Wheel Loader, Typical 1 -- Mean Torque Changes with Time  
For Torque Accelerations

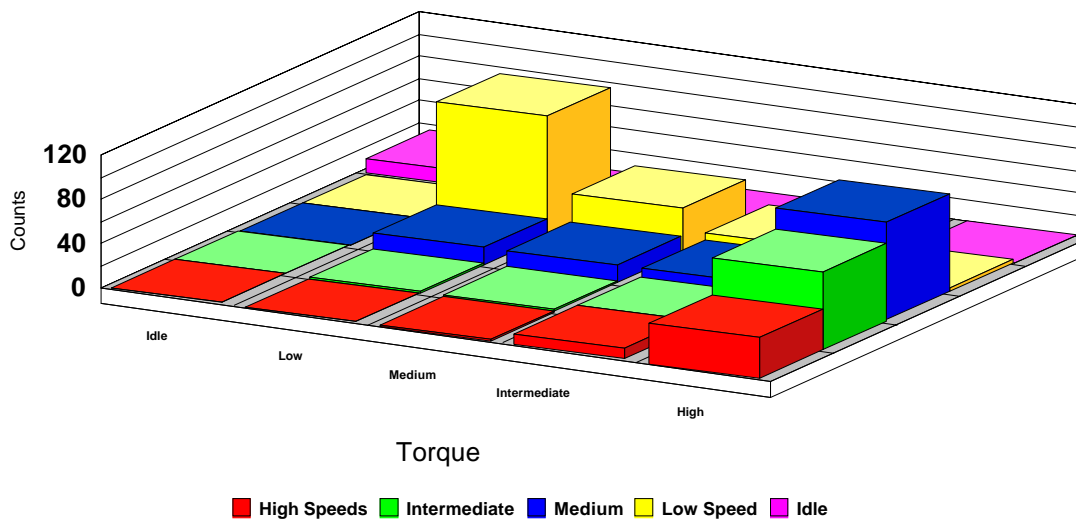


- K.1 *Wheel Loader--Typical 2 Small Bin Charts. See accompanying file appendixK1\_wheeloadt2.wpd.*
- L.1 *Wheel Loader--High Speed Transient Small Bin Charts. See accompanying file appendixL1\_wheeloadhs.wpd.*
- M.1 *Wheel Loader--High Torque Transient Small Bin Charts. See accompanying file appendixM1\_wheeloadht.wpd.*
- M.2 *Wheel Loader--High Torque Transient Big Bin Charts.*

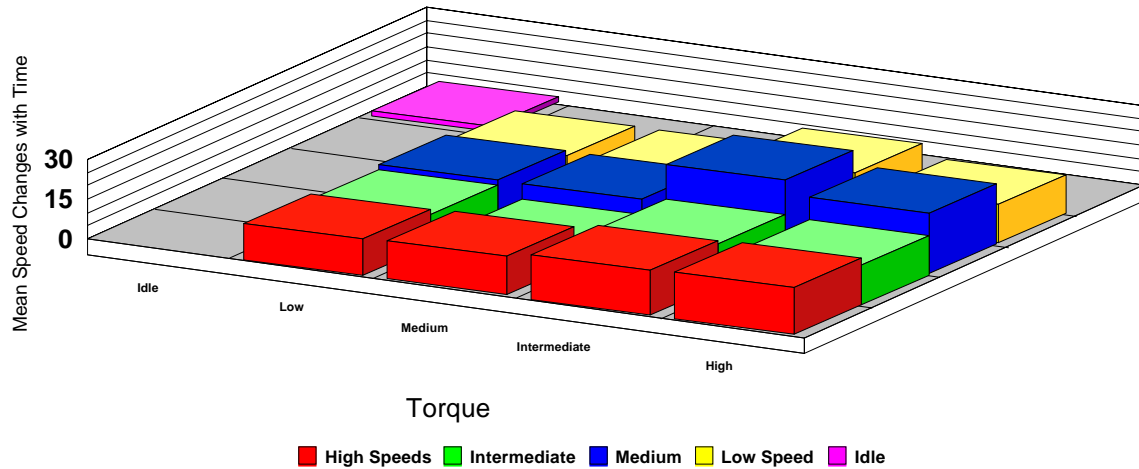
### Wheel Loader, High Torque Transient--Counts of Speed Accelerations



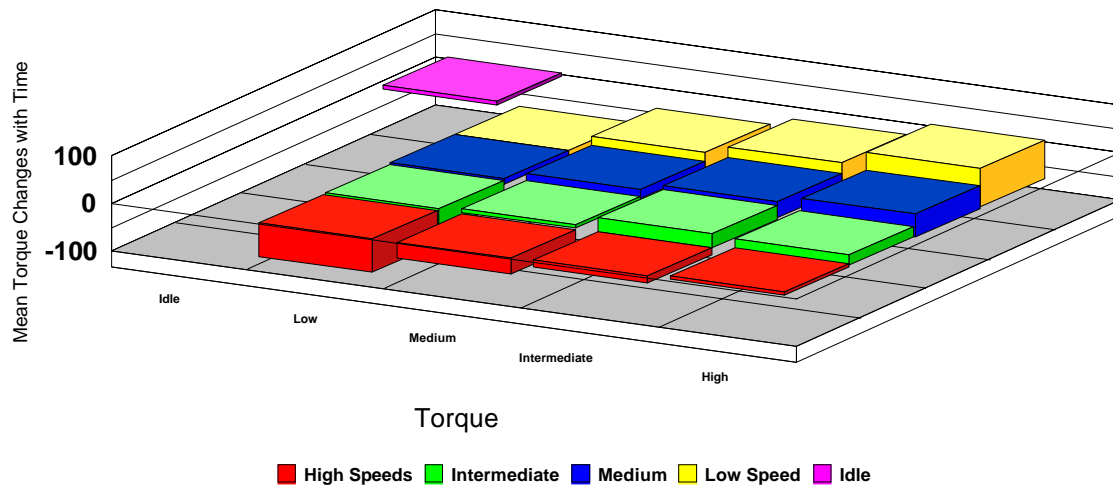
### Wheel Loader, High Torque Transient -- Counts of Torque Accelerations



Wheel Loader, High Torque Transient -- Mean Speed Changes with Time  
For Speed Accelerations

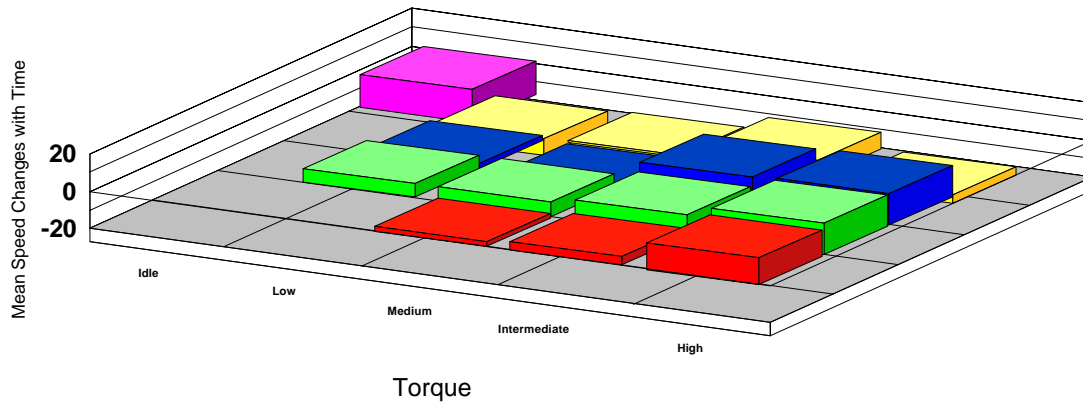


Wheel Loader, High Torque Transient -- Mean Torque Changes with Time  
For Speed Accelerations

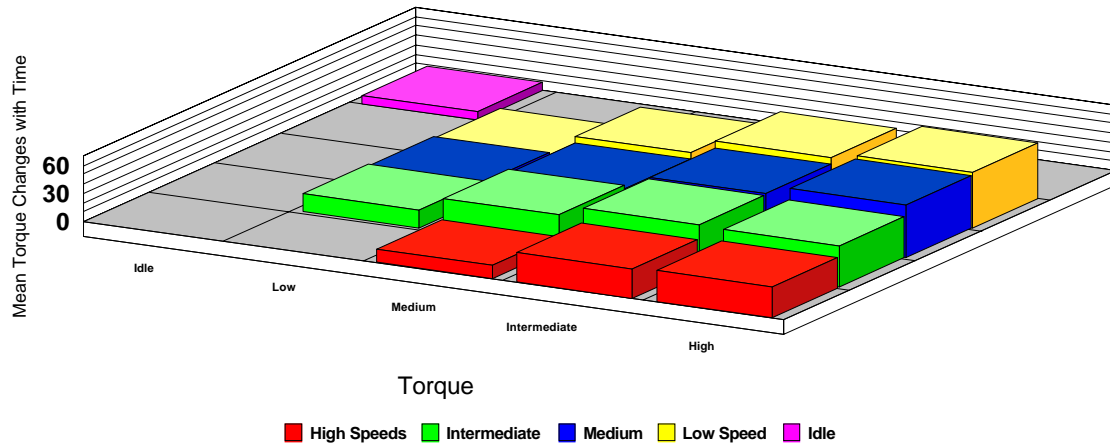




Wheel Loader, High Torque Transient -- Mean Speed Changes with Time  
For Torque Accelerations

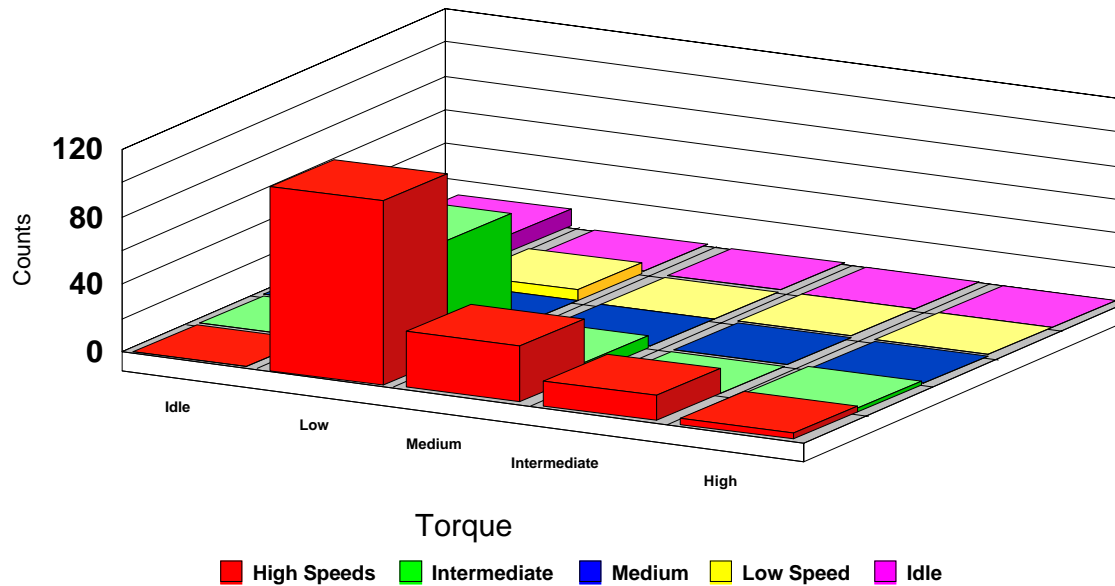


Wheel Loader, High Torque Transient -- Mean Torque Changes with Time  
For Torque Accelerations

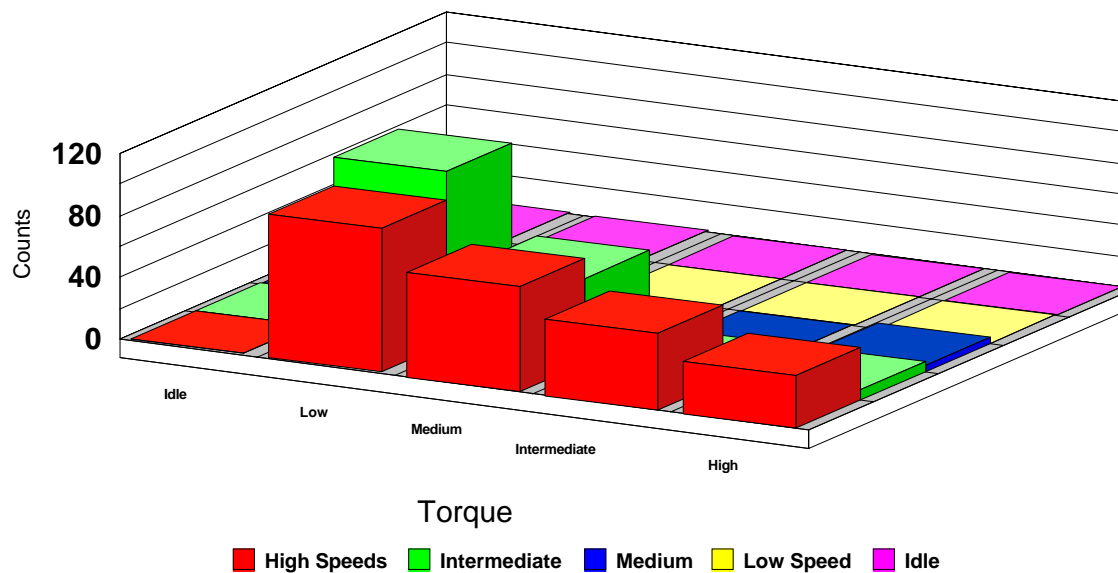


- N.1 *Skid Steer Loader--Typical 1 Small Bin Charts. See accompanying file appendixN1\_skidsteert1.wpd.*
- N.2 *Skid Steer Loader--Typical 1 Big Bin Charts*

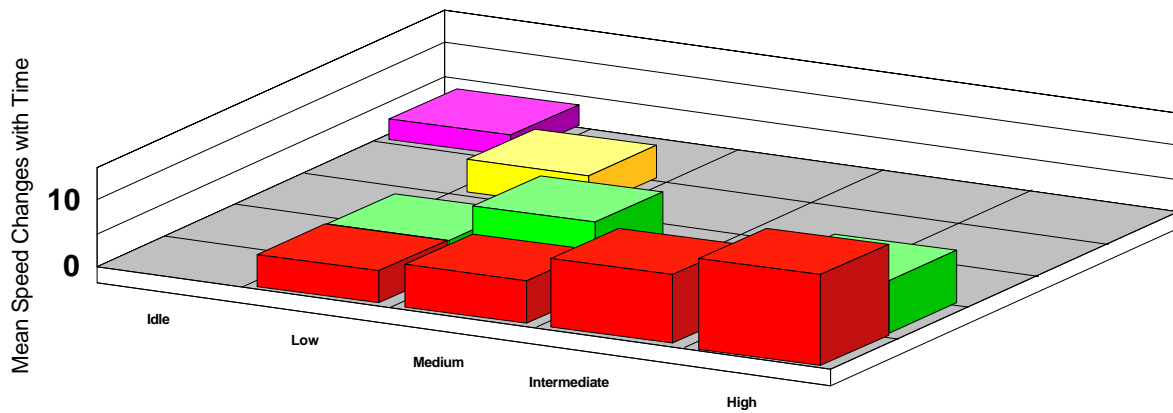
## Skid Steer Loader, Typical 1 -- Counts of Speed Accelerations



## Skid Steer Loader, Typical 1 -- Counts of Torque Accelerations



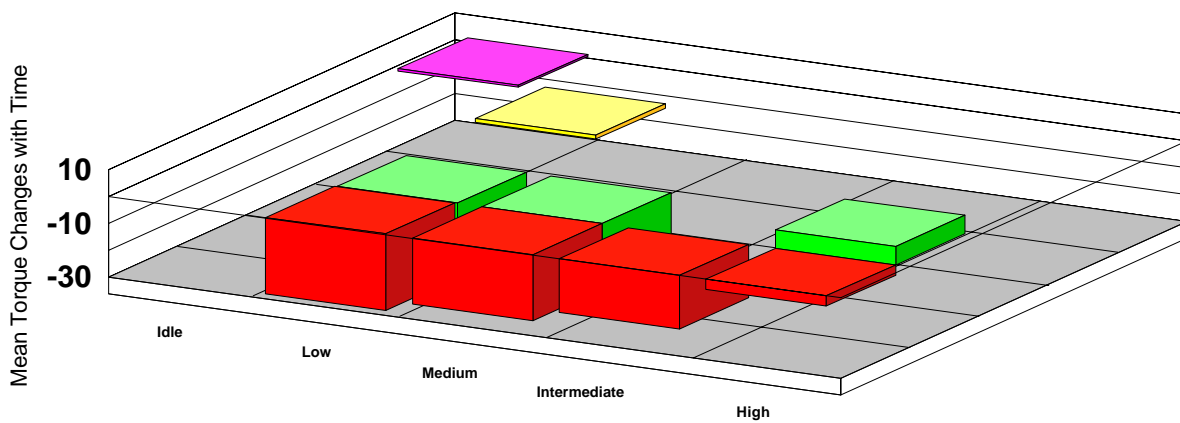
Skid Steer Loader, Typical 1 -- Mean Speed Changes with Time  
For Speed Accelerations



Torque

High Speeds Medium Idle  
Intermediate Low Speed

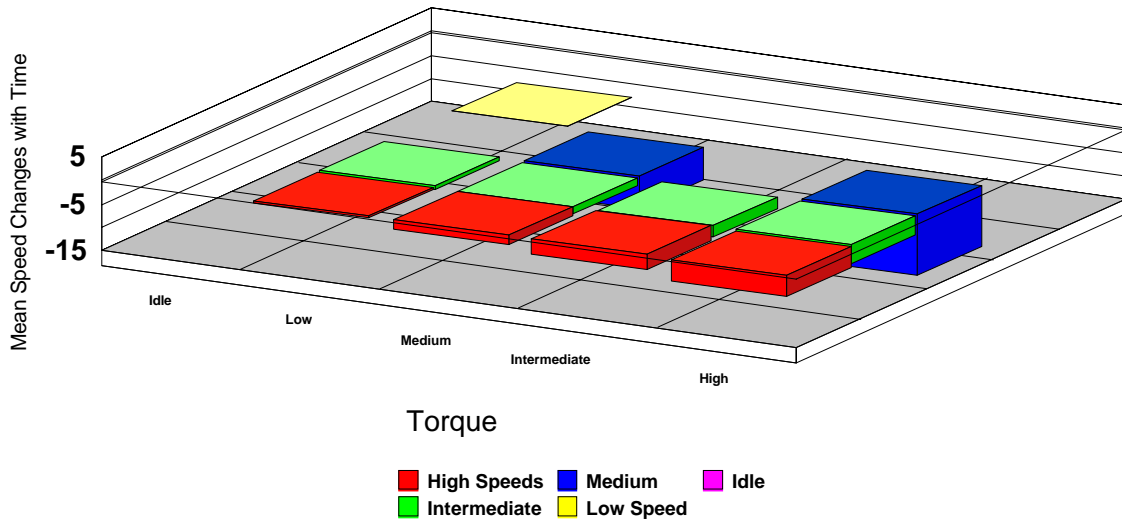
Skid Steer Loader, Typical 1 -- Mean Torque Changes with Time  
For Speed Accelerations



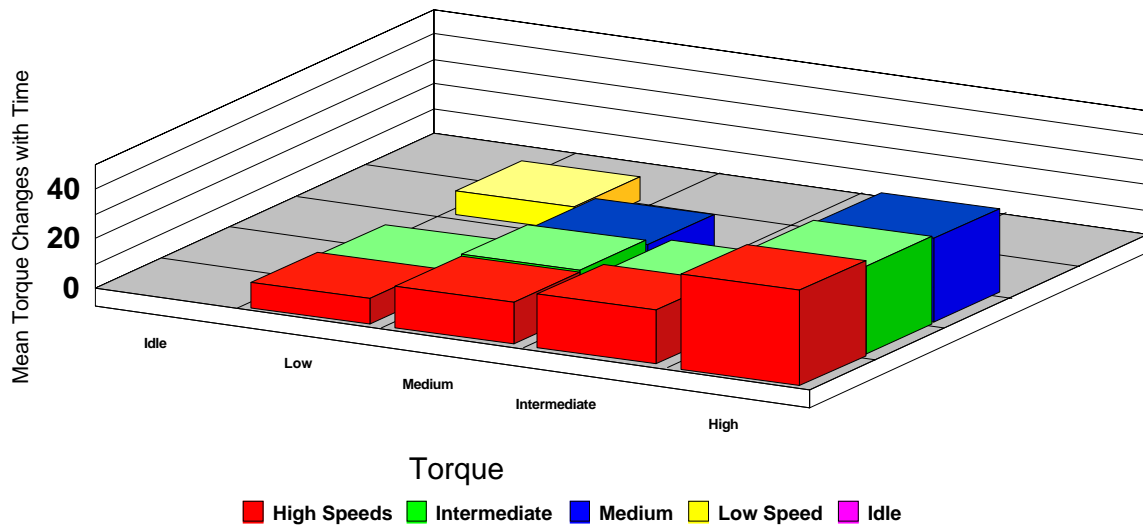
Torque

High Speeds Medium Idle  
Intermediate Low Speed

Skid Steer Loader, Typical 1 -- Mean Speed Changes with Time  
For Torque Accelerations

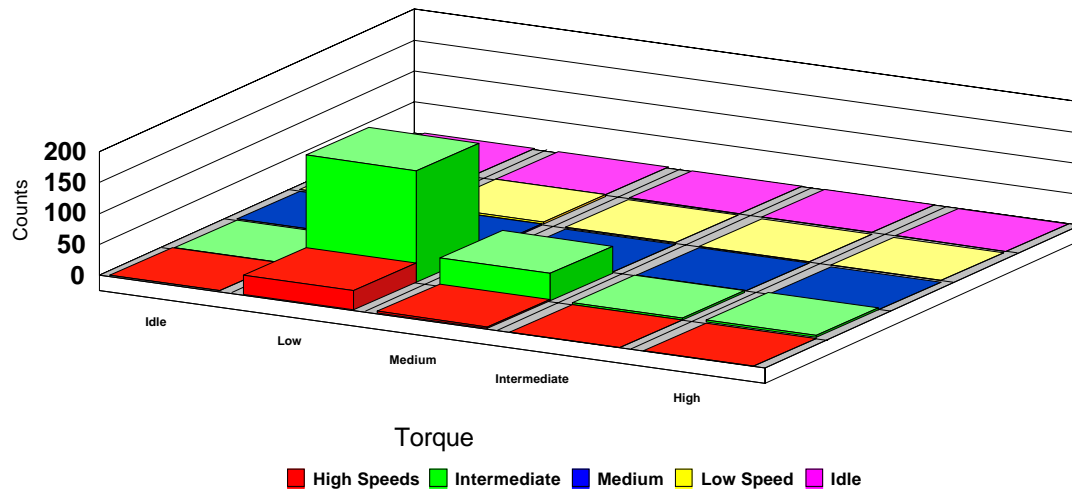


Skid Steer Loader, Typical 1 -- Mean Torque Changes with Time  
For Torque Accelerations

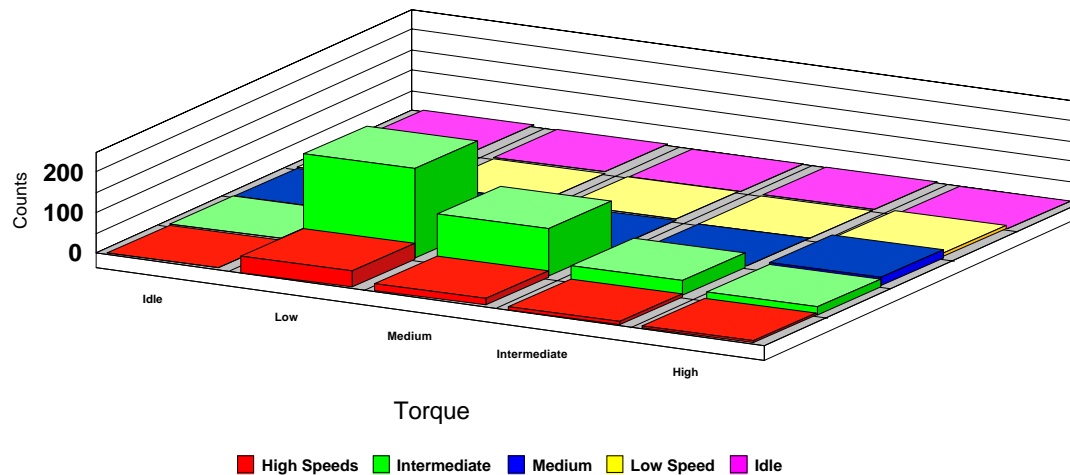


- O.1 *Skid Steer Loader--Typical 2 Small Bin Charts.* See accompanying file appendixO1\_skidsteert2.wpd.
- P.1 *Skid Steer Loader--High Speed Transient Small Bin Charts.* See accompanying file appendixP1\_skidsteerhs.wpd.
- Q.1 *Skid Steer Loader--High Torque Transient Small Bin Charts.* See accompanying file appendixQ1\_skidsteerht.wpd.
- Q.2 *Skid Steer Loader--High Torque Transient Big Bin Charts*

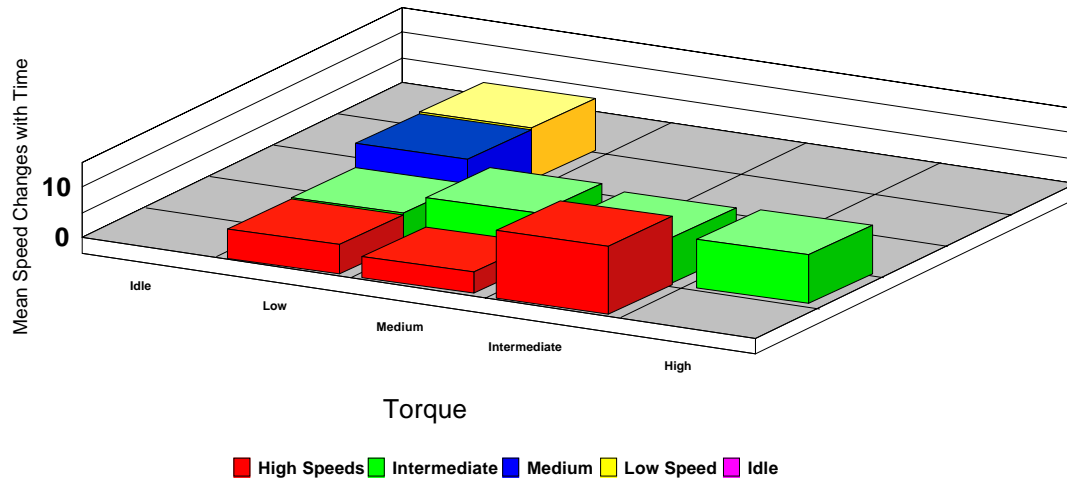
### Skid Steer Loader, High Torque Transient--Counts of Speed Accelerations



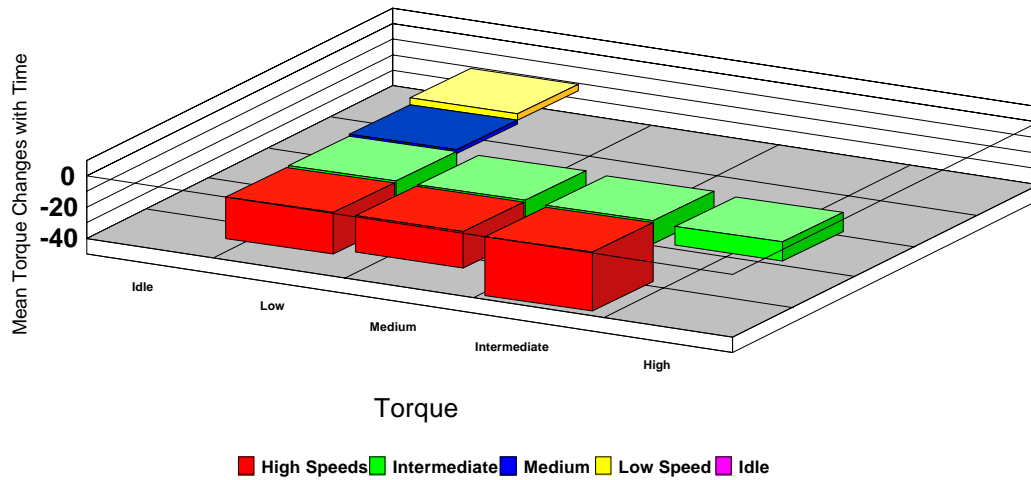
### Skid Steer Loader, High Torque Transient -- Counts of Torque Accelerations



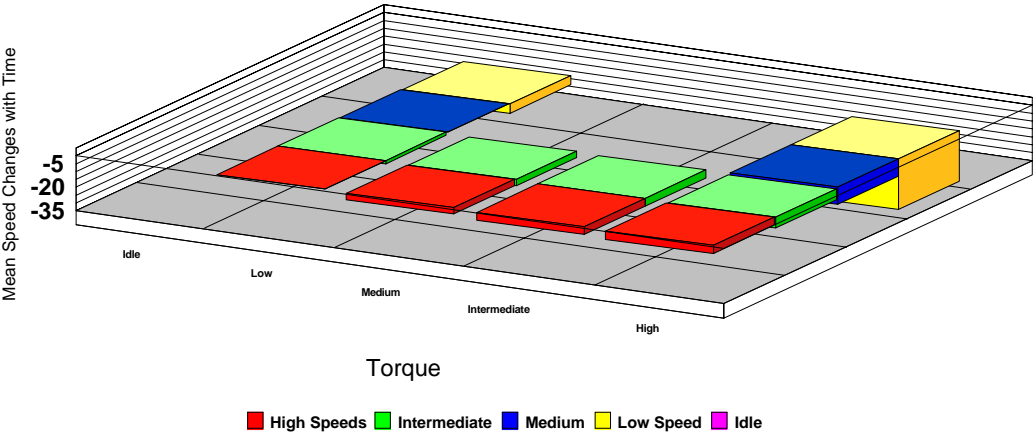
Skid Steer Loader, High Torque Transient -- Mean Speed Changes with  
For Speed Accelerations



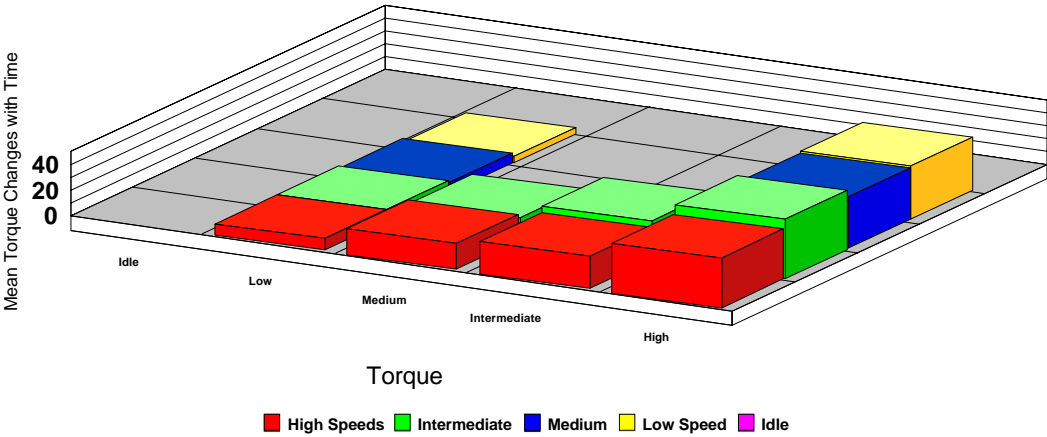
Skid Steer Loader, High Torque Transient -- Mean Torque Changes wi  
For Speed Accelerations



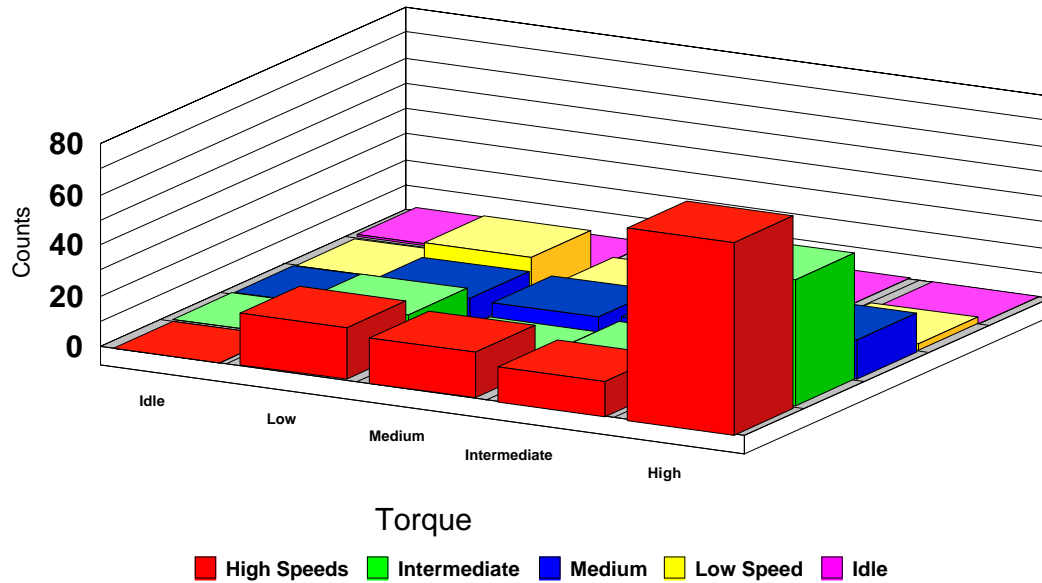
Wheel Loader, High Torque Transient -- Mean Speed Changes with Time  
For Torque Accelerations



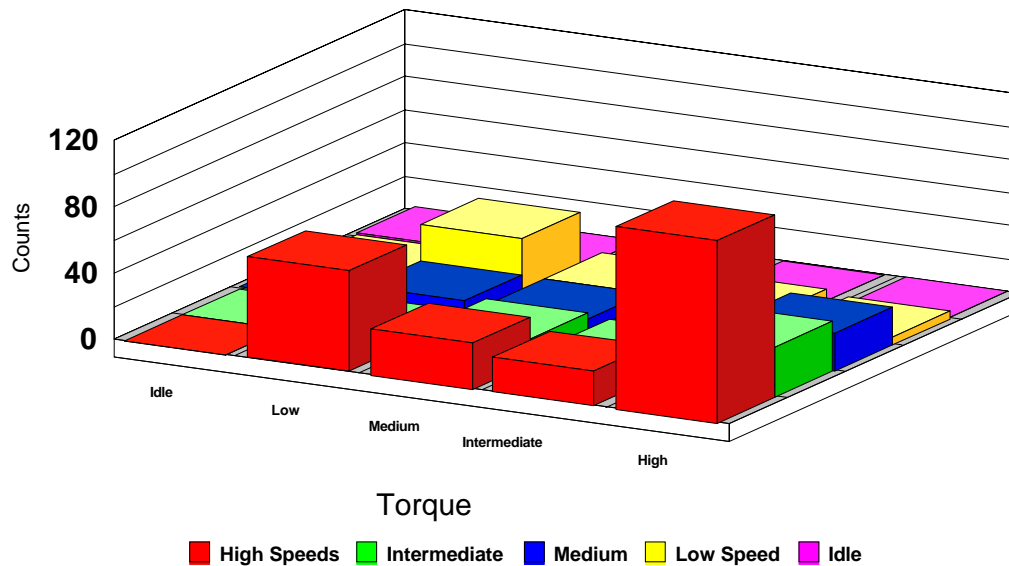
Skid Steer Loader, High Torque Transient -- Mean Torque Changes with Time  
For Torque Accelerations



Excavator -- Counts of Speed Accelerations

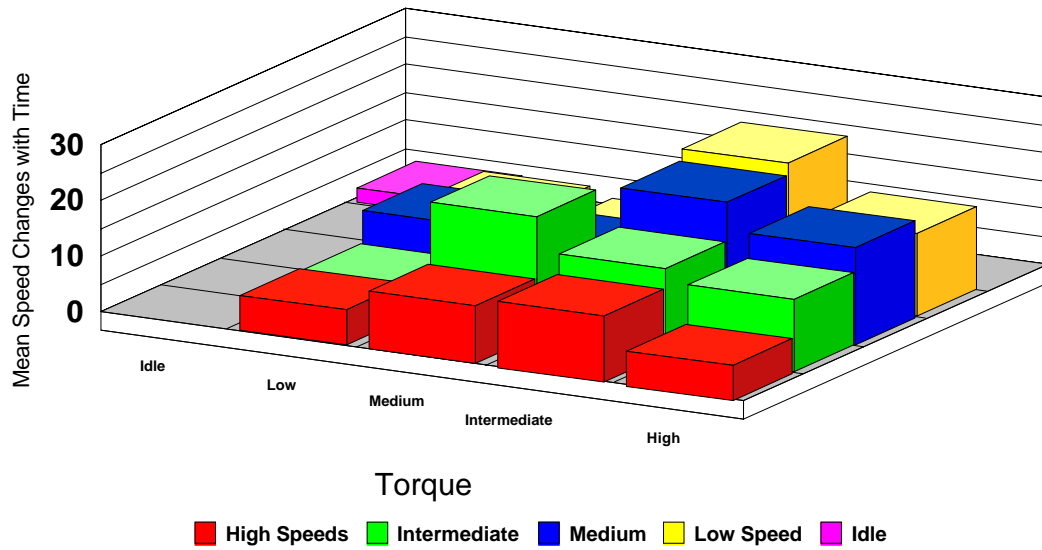


Excavator -- Counts of Torque Accelerations

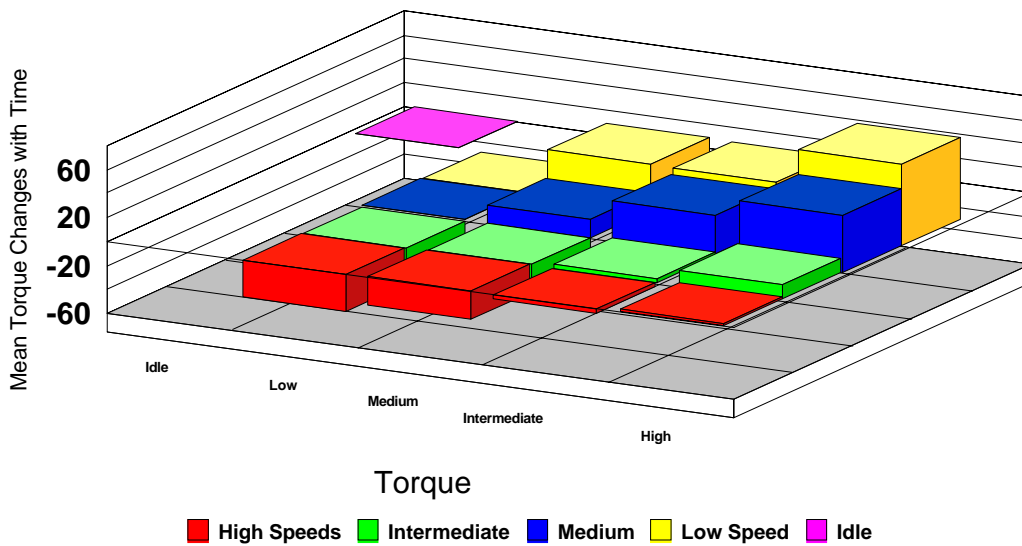




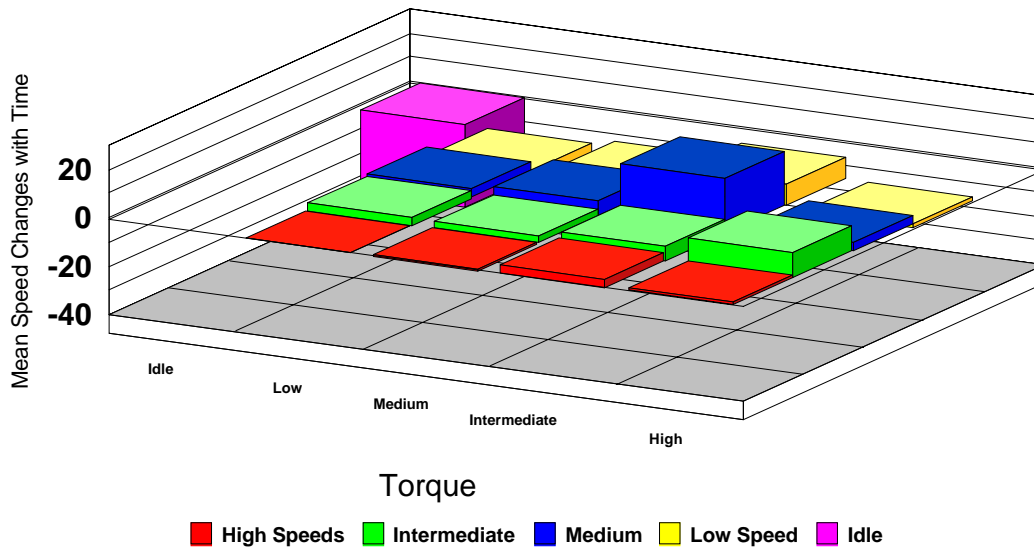
Excavator -- Mean Speed Changes with Time  
For Speed Accelerations



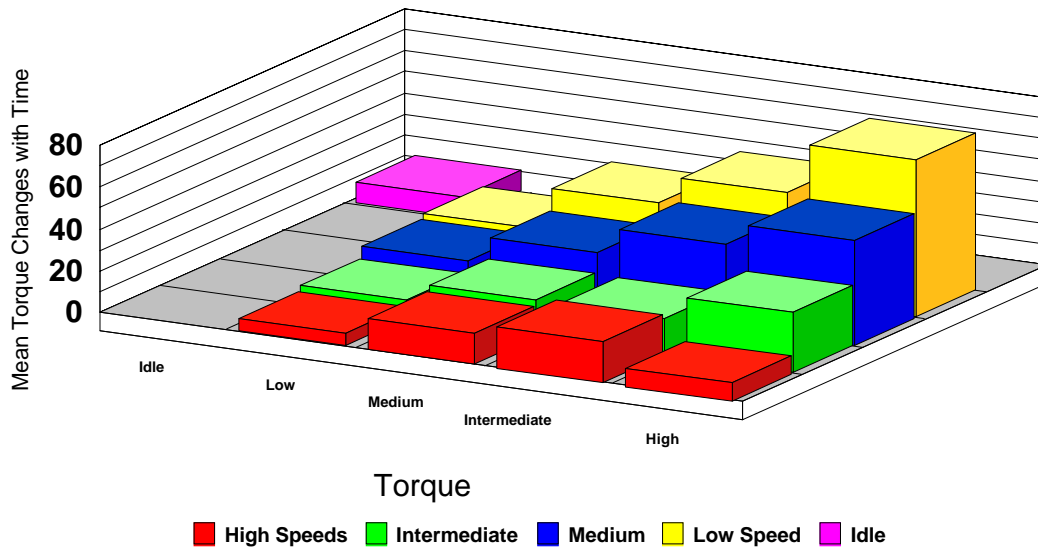
Excavator -- Mean Torque Changes with Time  
For Speed Accelerations



Excavator -- Mean Speed Changes with Time  
For Torque Accelerations

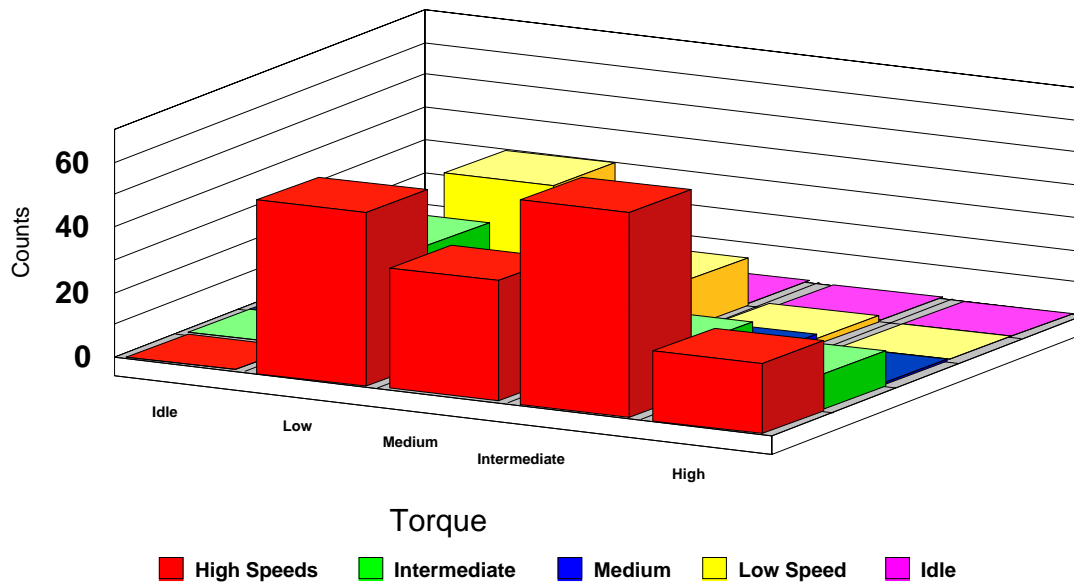


Excavator -- Mean Torque Changes with Time  
For Torque Accelerations

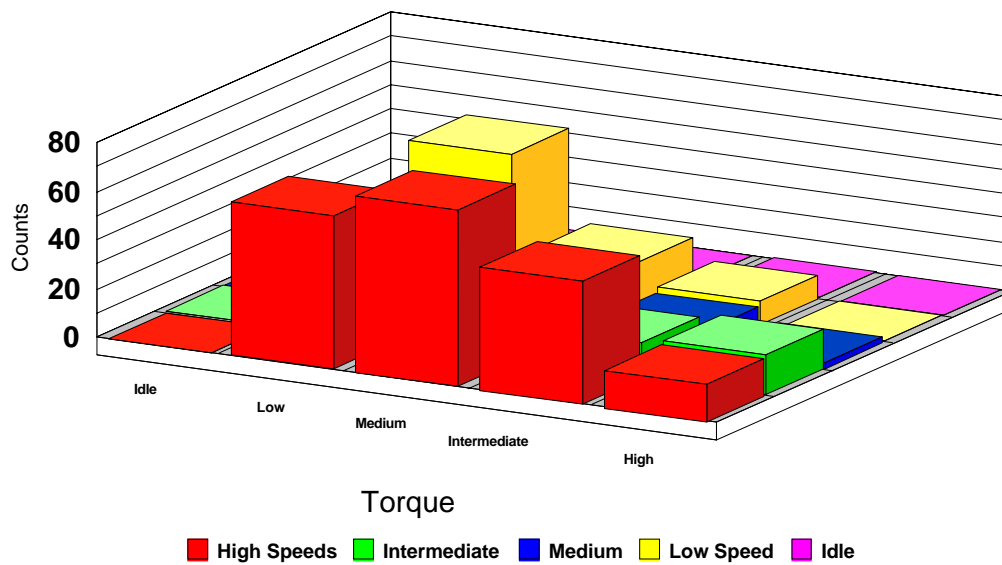


- S.1 *Nonroad Transient Small Bin Charts.* See accompanying file appendixS1\_nrc.wpd.  
 S.2 *Nonroad Transient Big Bin Charts*

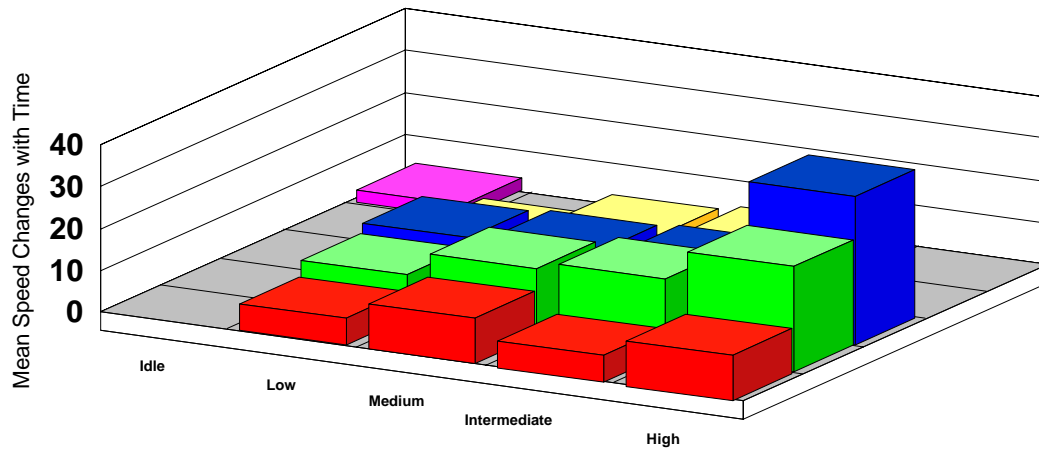
### NRC -- Counts of Speed Accelerations



### NRC -- Counts of Torque Accelerations



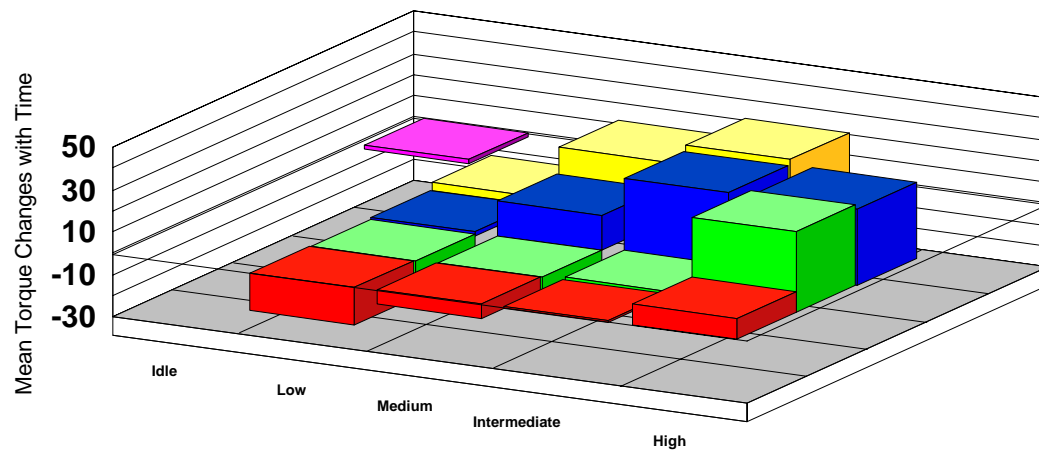
**NRC -- Mean Speed Changes with Time**  
For Speed Accelerations



Torque

High Speeds Intermediate Medium Low Speed Idle

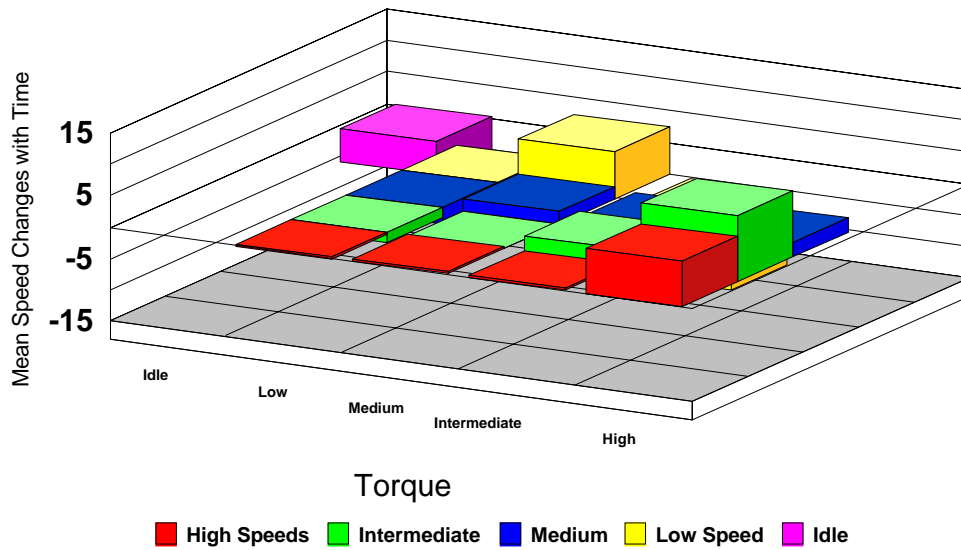
**NRC -- Mean Torque Changes with Time**  
For Speed Accelerations



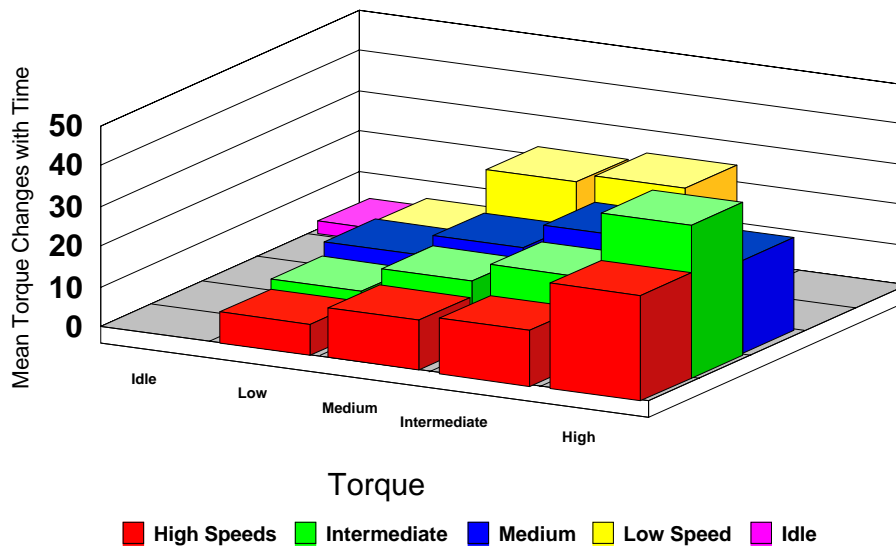
Torque

High Speeds Intermediate Medium Low Speed Idle

**NRC -- Mean Speed Changes with Time**  
For Torque Accelerations

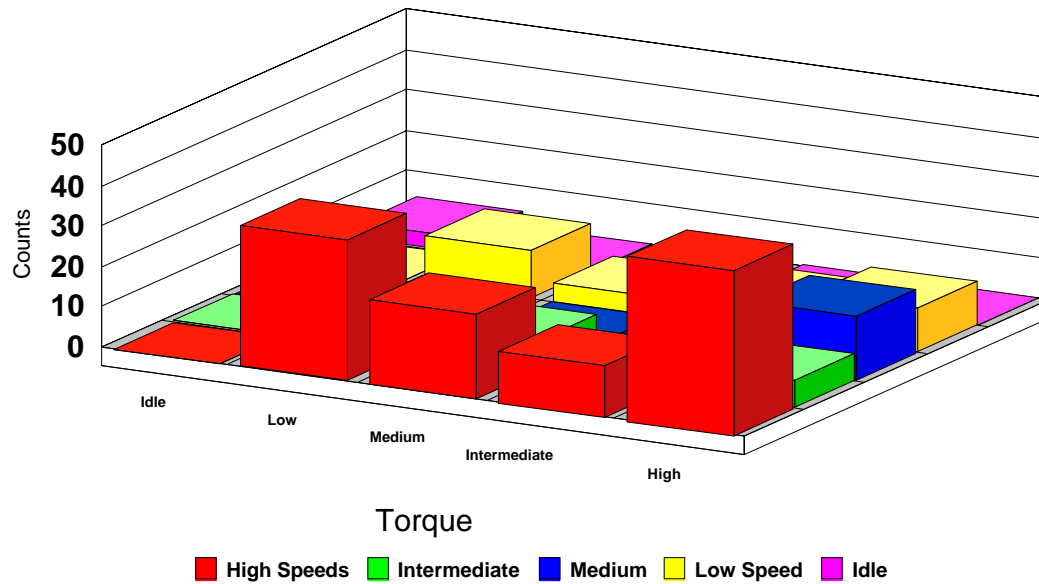


**NRC -- Mean Torque Changes with Time**  
For Torque Accelerations

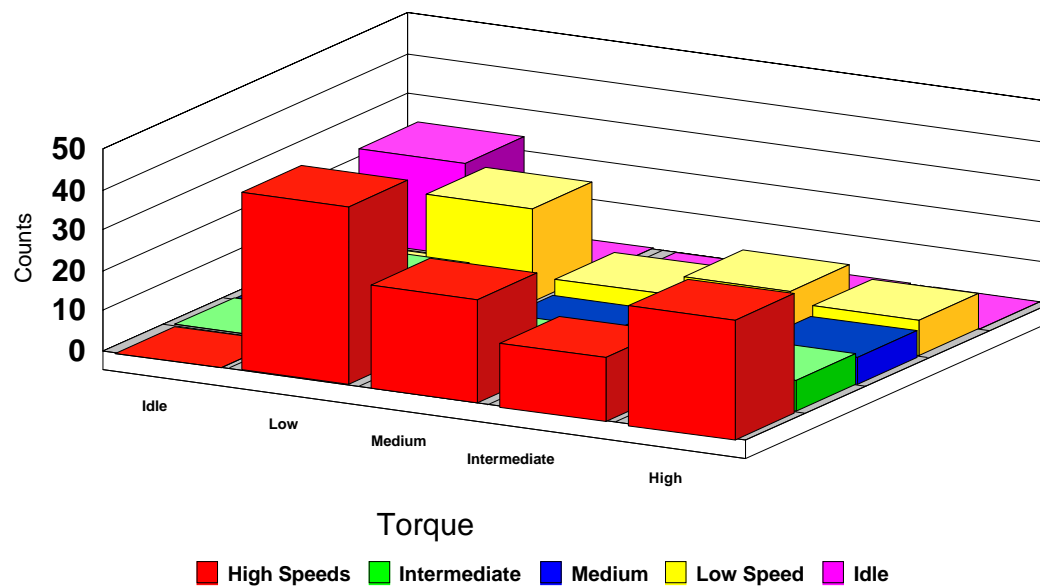


- T.1 FTP DCS4 Small Bin Charts. See accompanying file appendixT1\_ftp.wpd  
T.2 FTP DCS4 Big Bin Charts

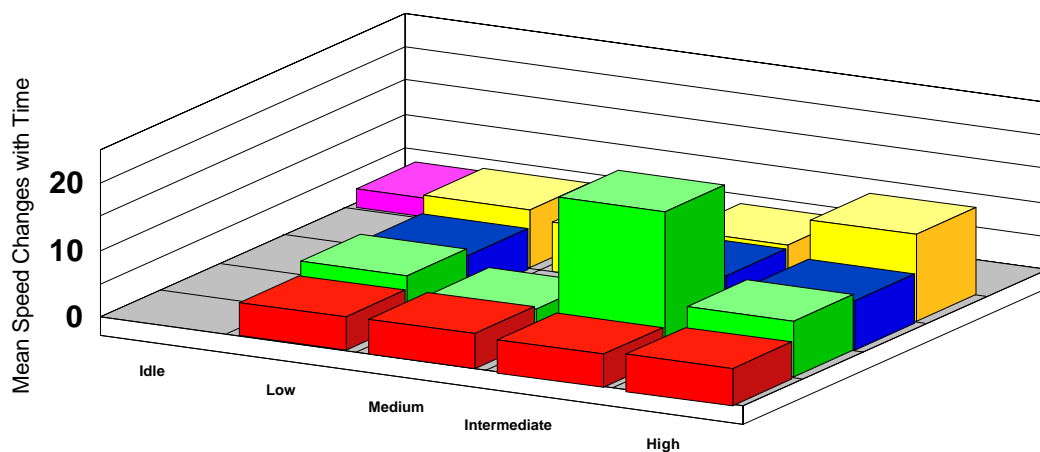
### FTP -- Counts of Speed Accelerations



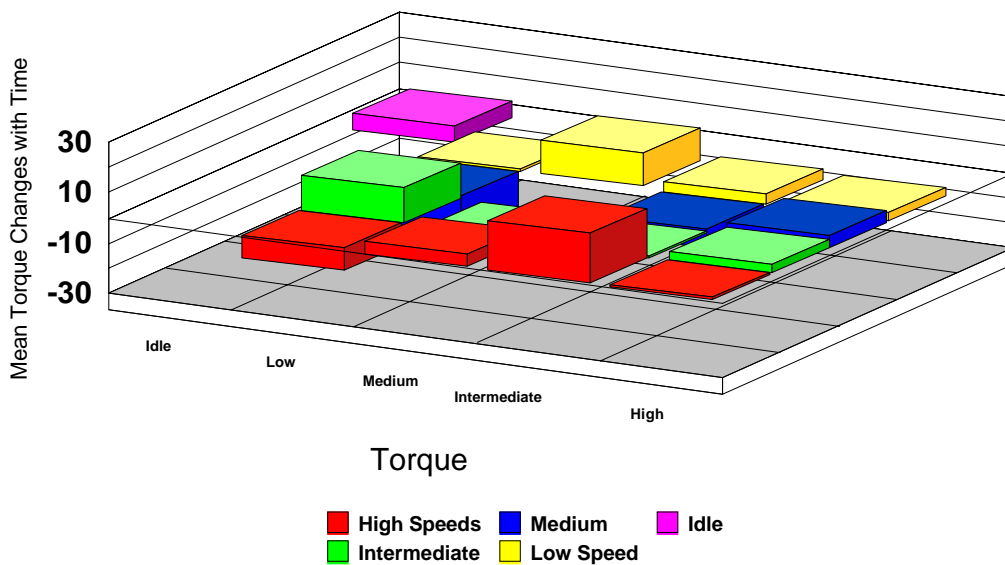
### FTP -- Counts of Torque Accelerations



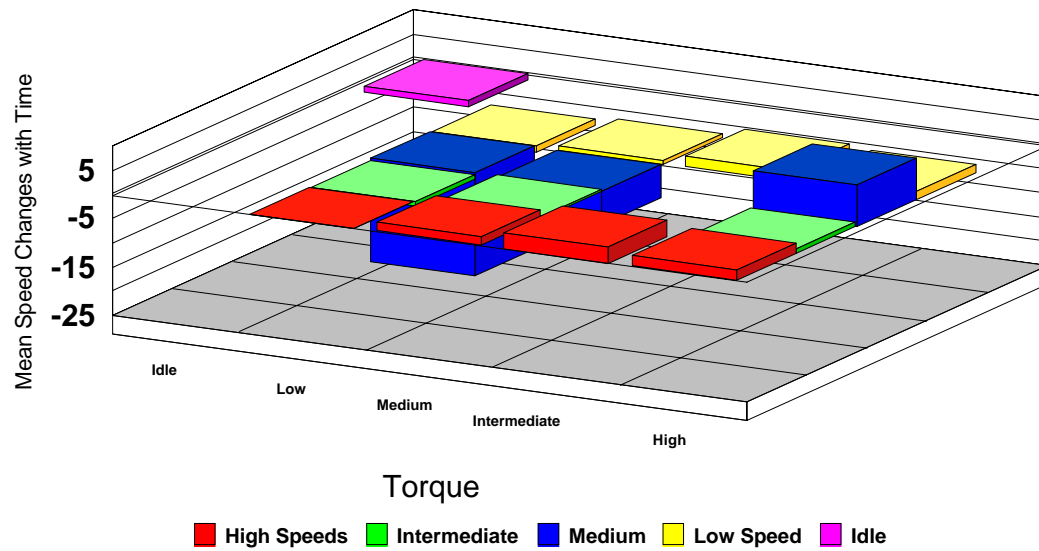
FTP -- Mean Speed Changes with Time  
For Speed Accelerations



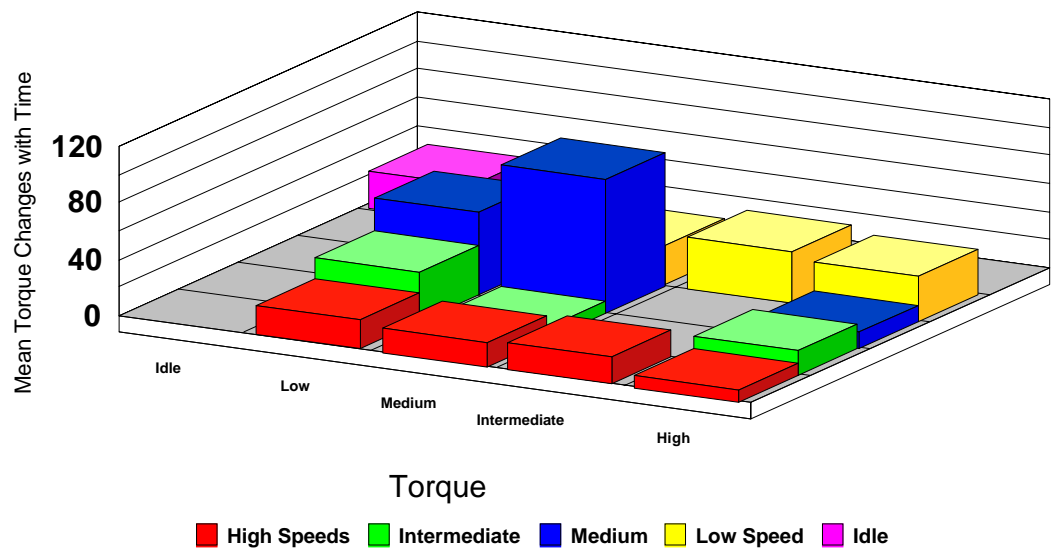
FTP -- Mean Torque Changes with Time  
For Speed Accelerations



FTP -- Mean Speed Changes with Time  
For Torque Accelerations

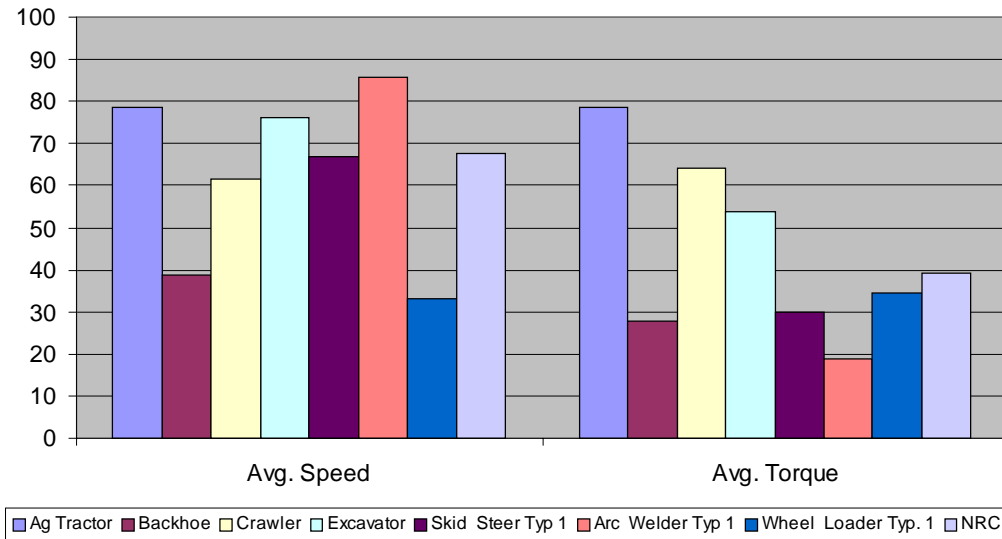


FTP -- Mean Torque Changes with Time  
For Torque Accelerations

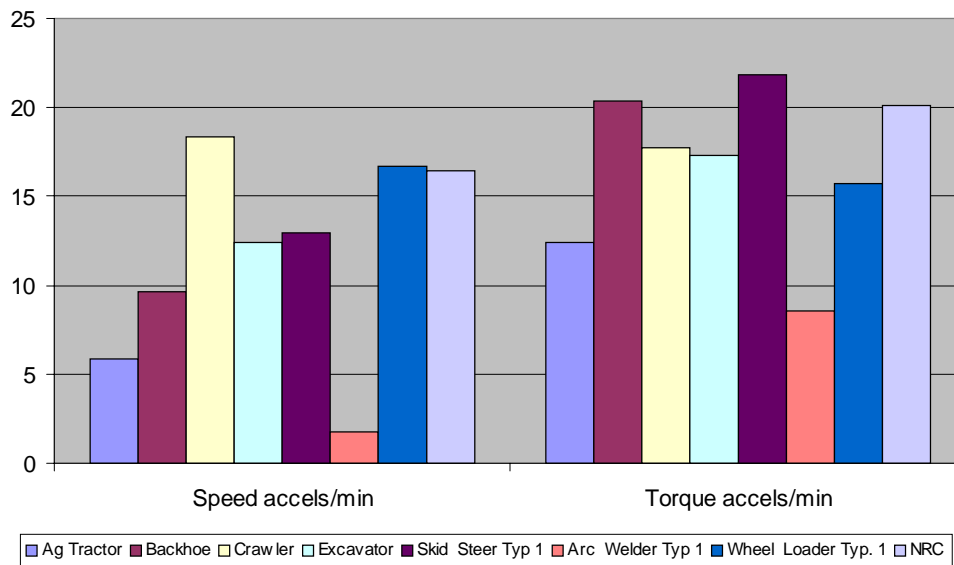




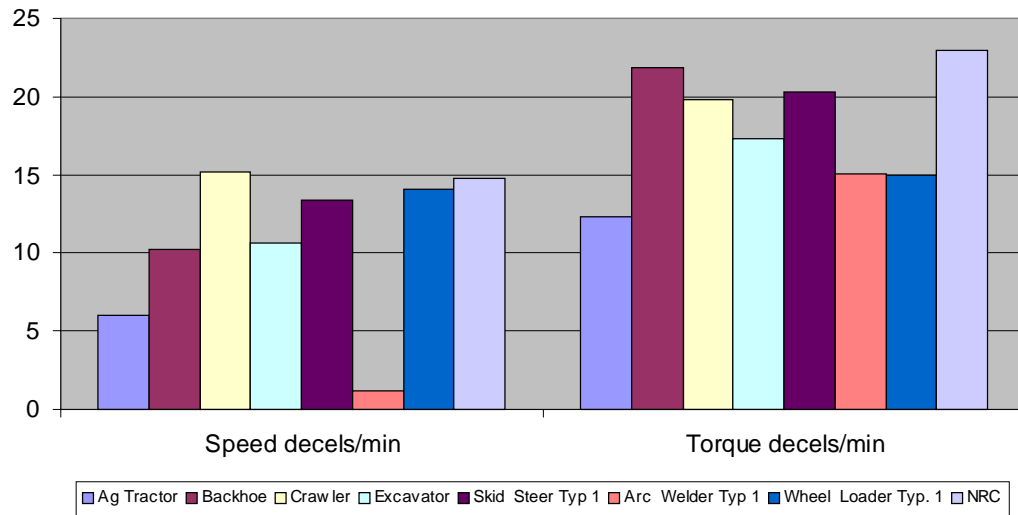
**Speed-Torque Averages for all Cycles**



**Speed-Torque Accelerations for all Cycles**

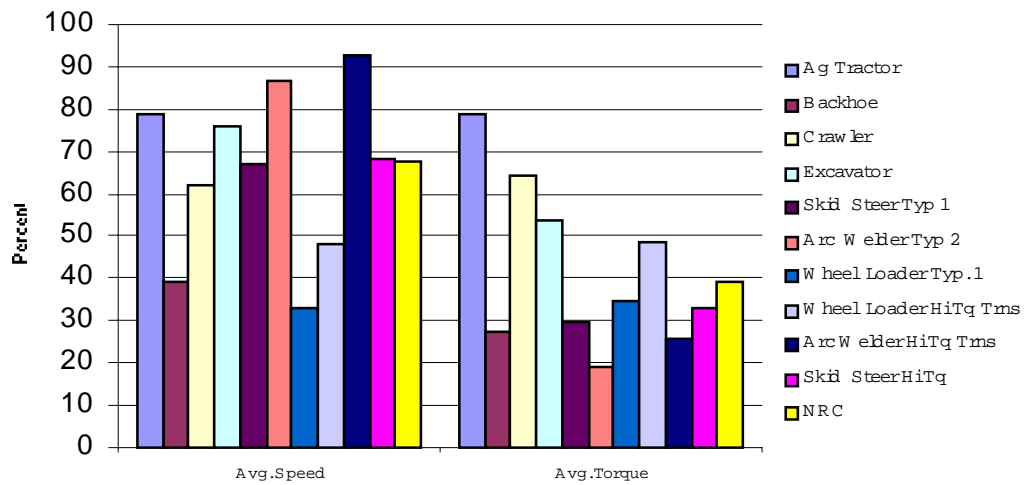


## Speed-Torque Decelerations for Representative Cycles

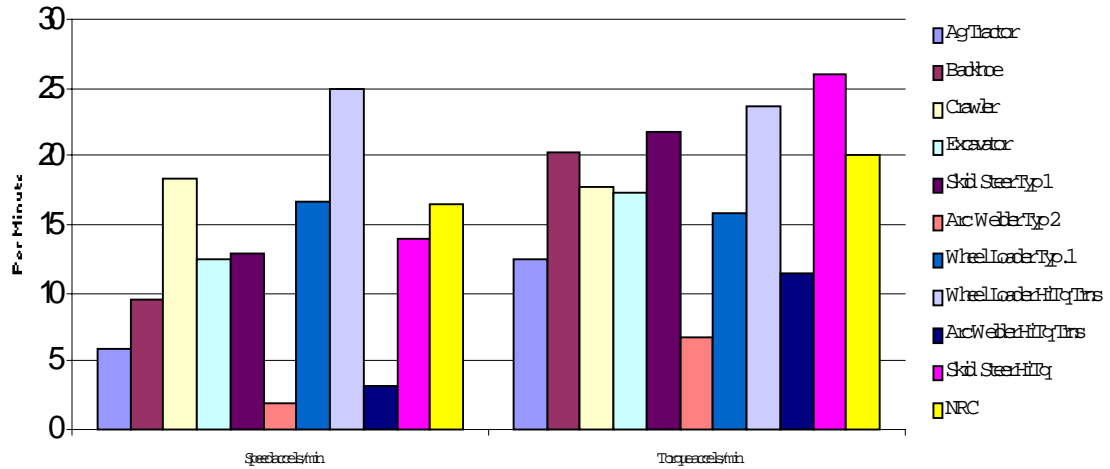


### U.2 NRC Comparisons with 10 Typical and High Torque Cycles

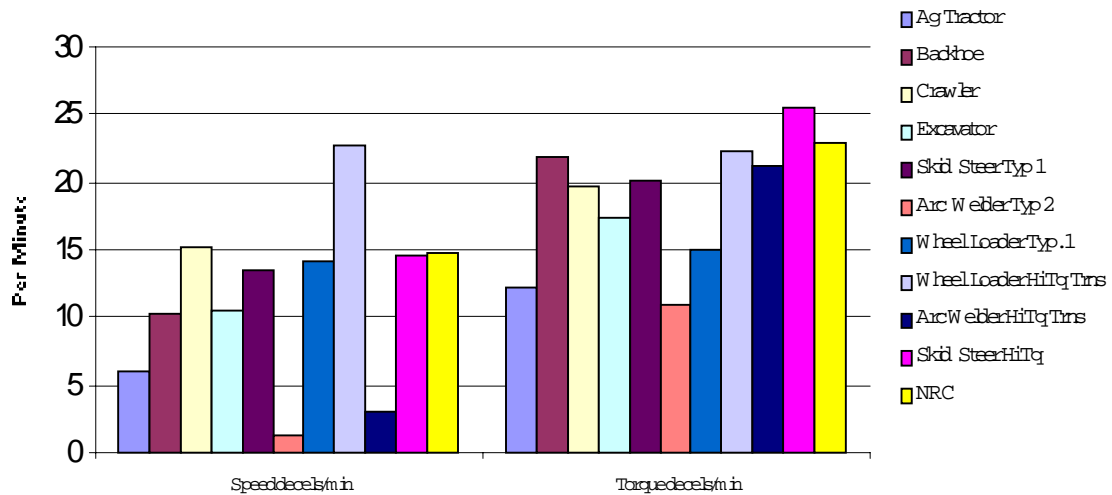
## Cycle Comparisons--Average Speed and Torque



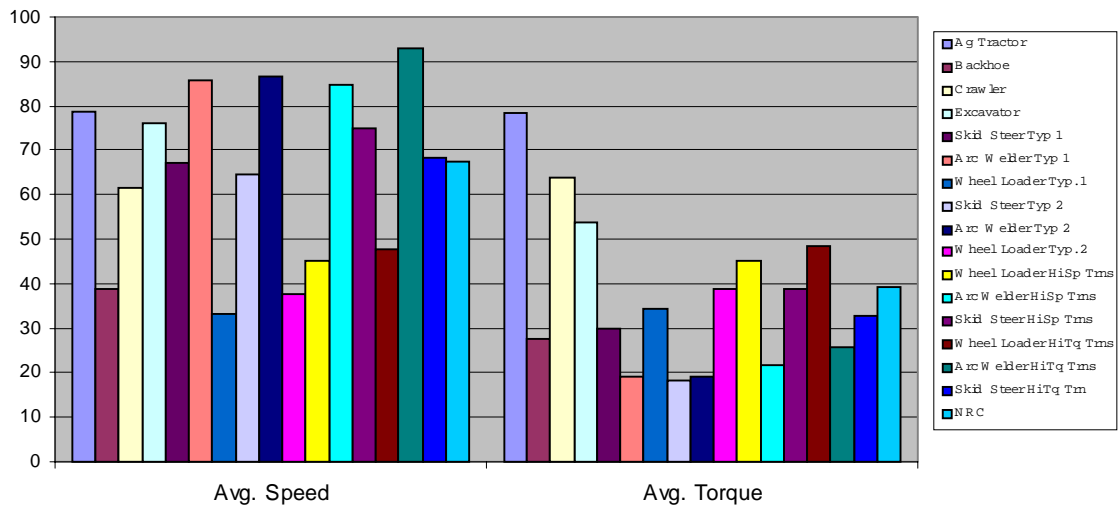
### Cycle Comparisons for Speed and Torque Accelerations



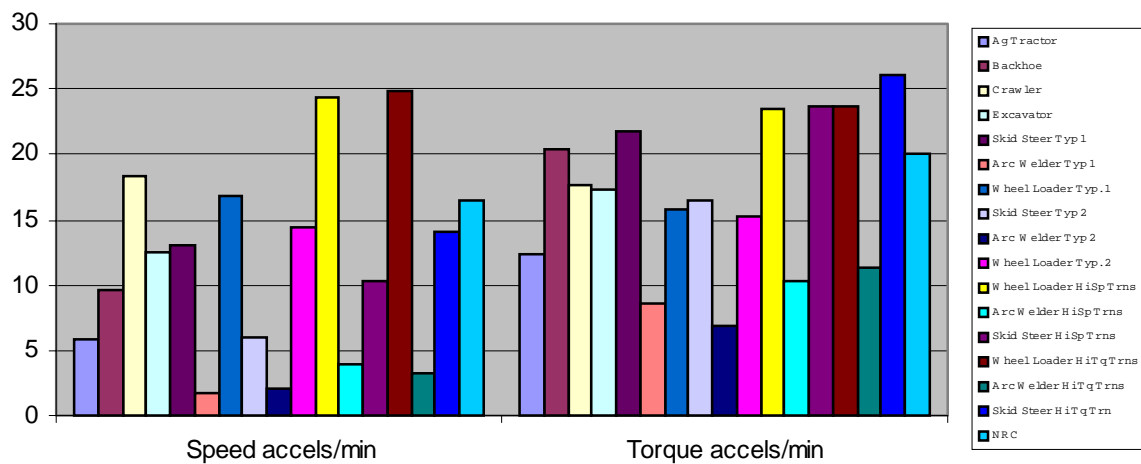
### Cycle Comparisons of Speed and Torque Decelerations



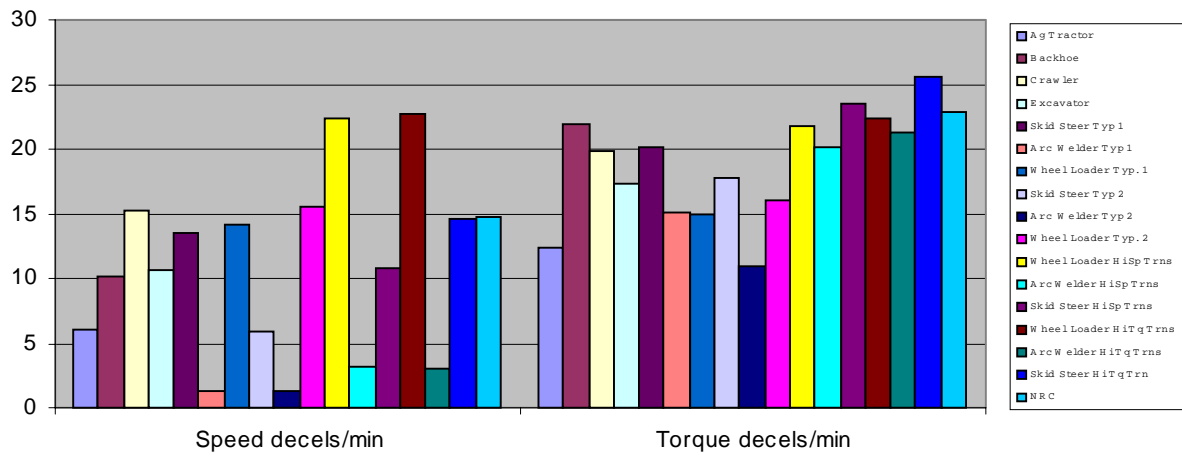
## Speed-Torque Averages for all Cycles



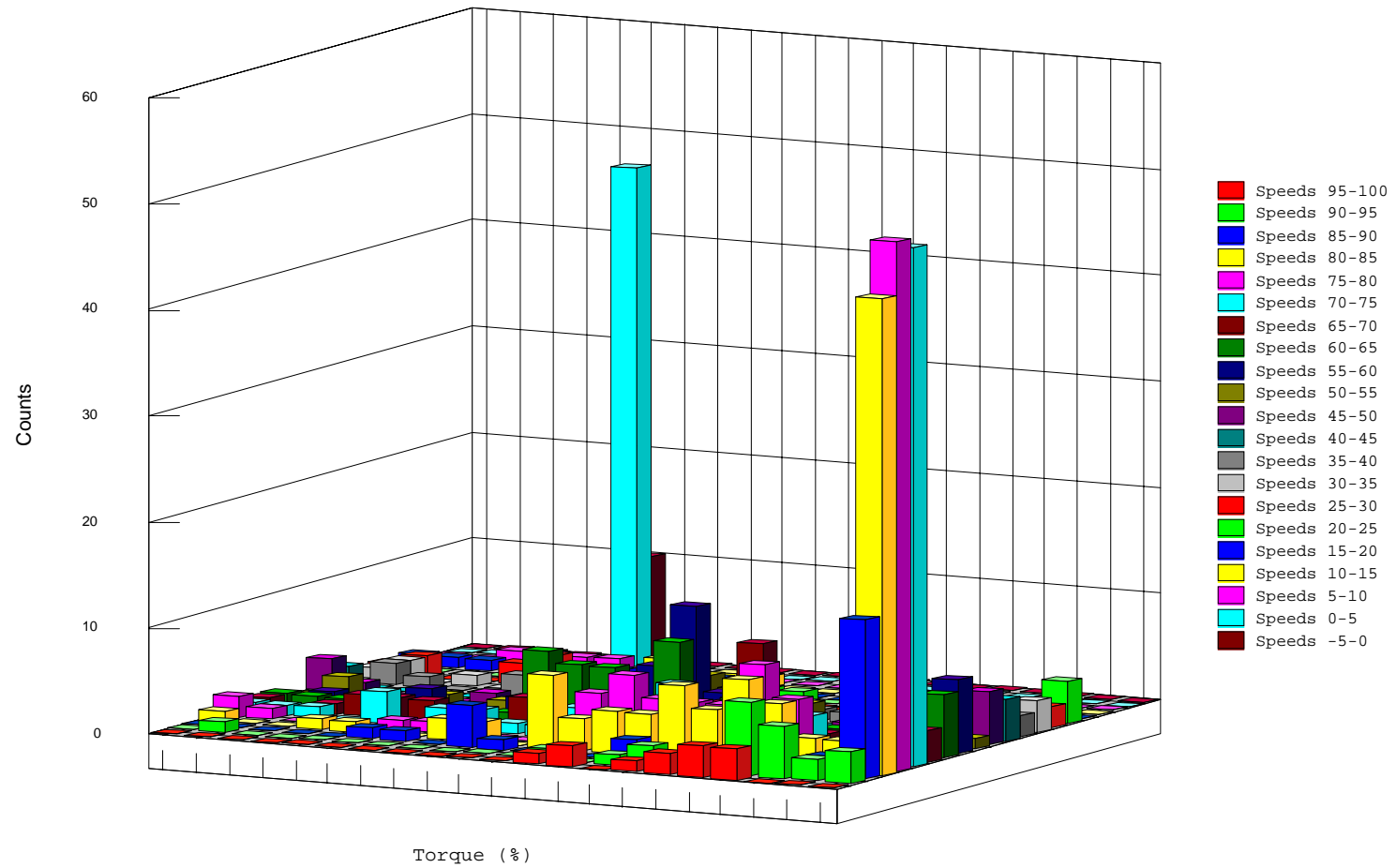
## Speed-Torque Accelerations for all Cycles



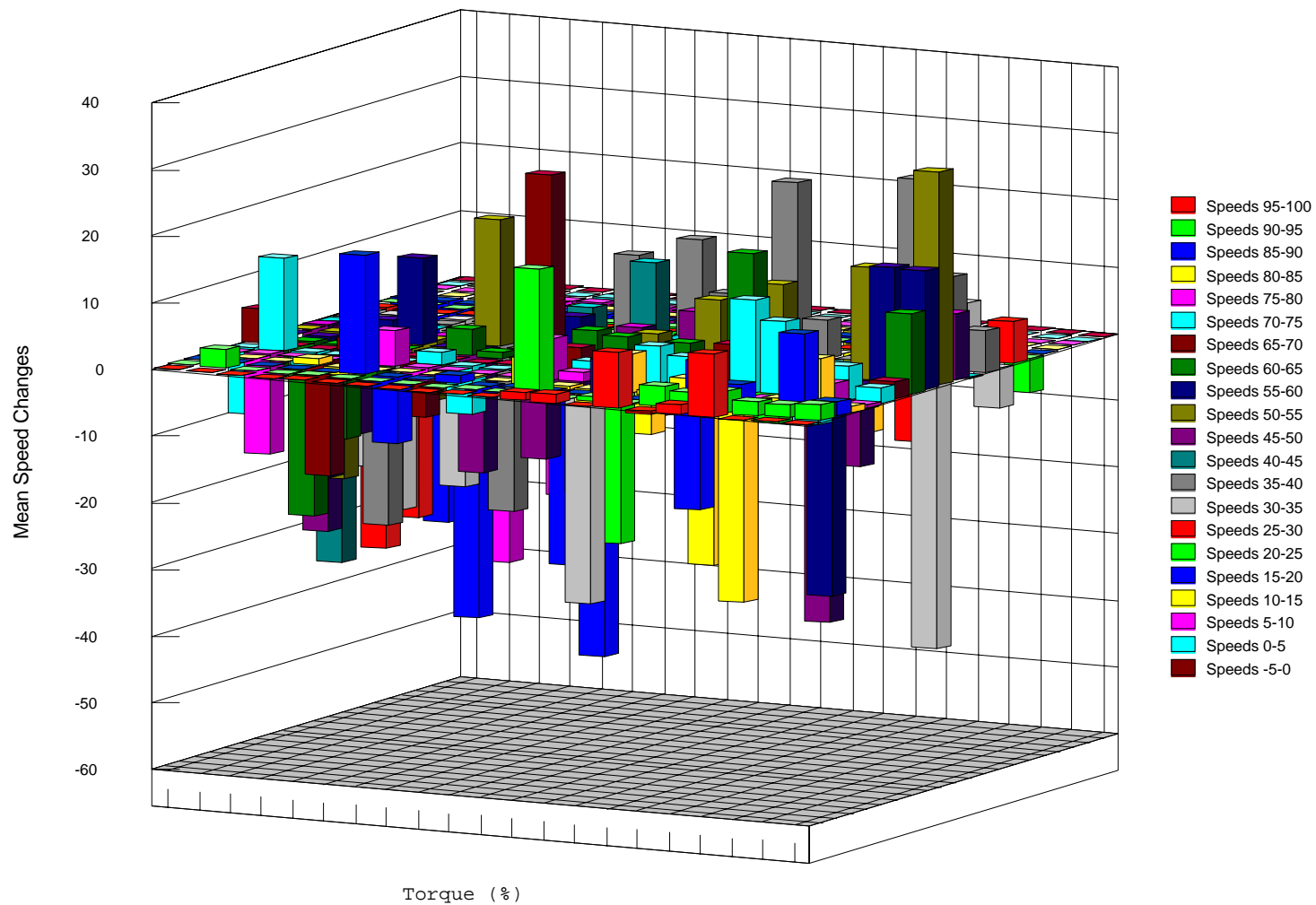
## Speed-Torque Decelerations for all Cycles



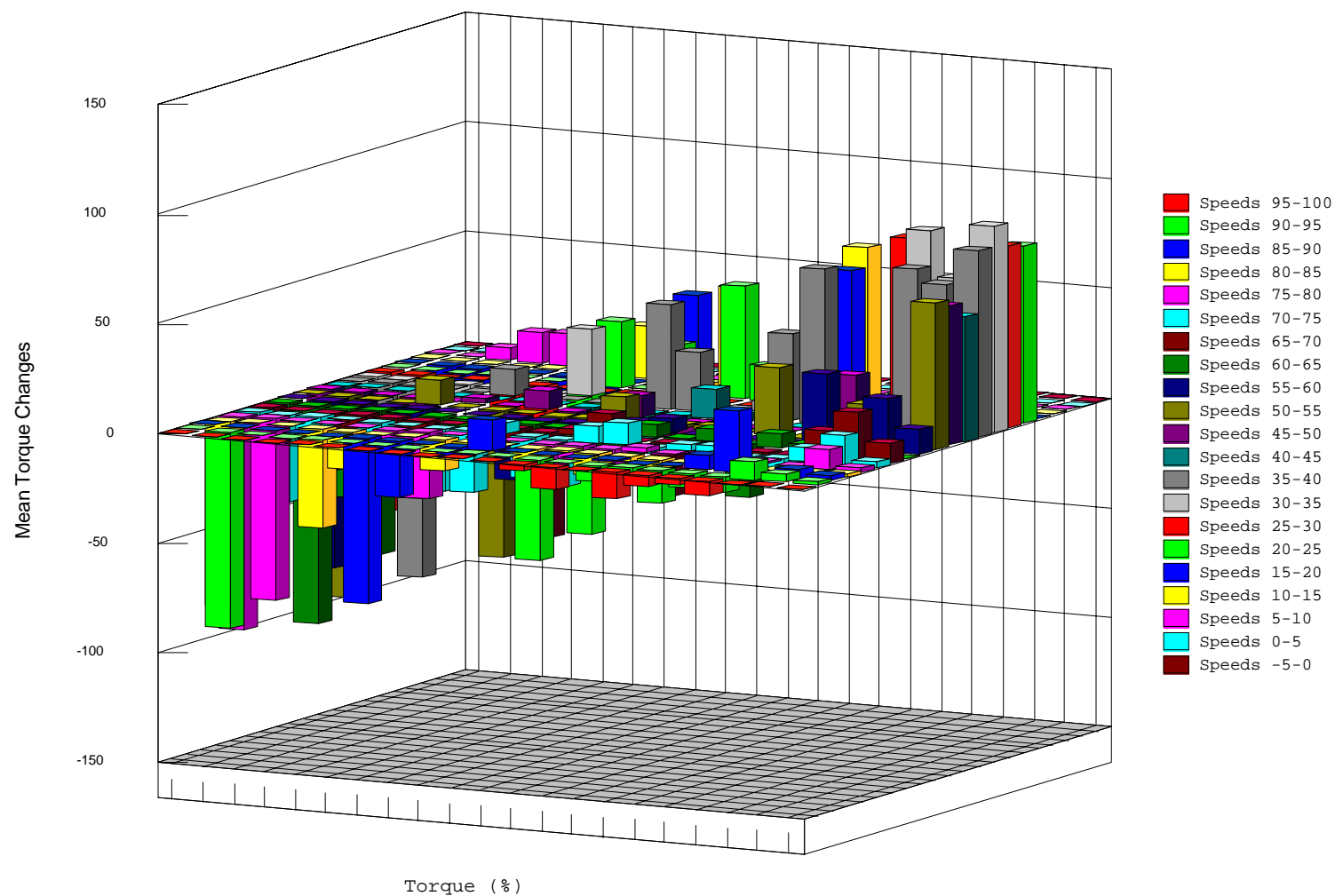
## Crawler--Counts



# Crawler--Mean Speed Changes

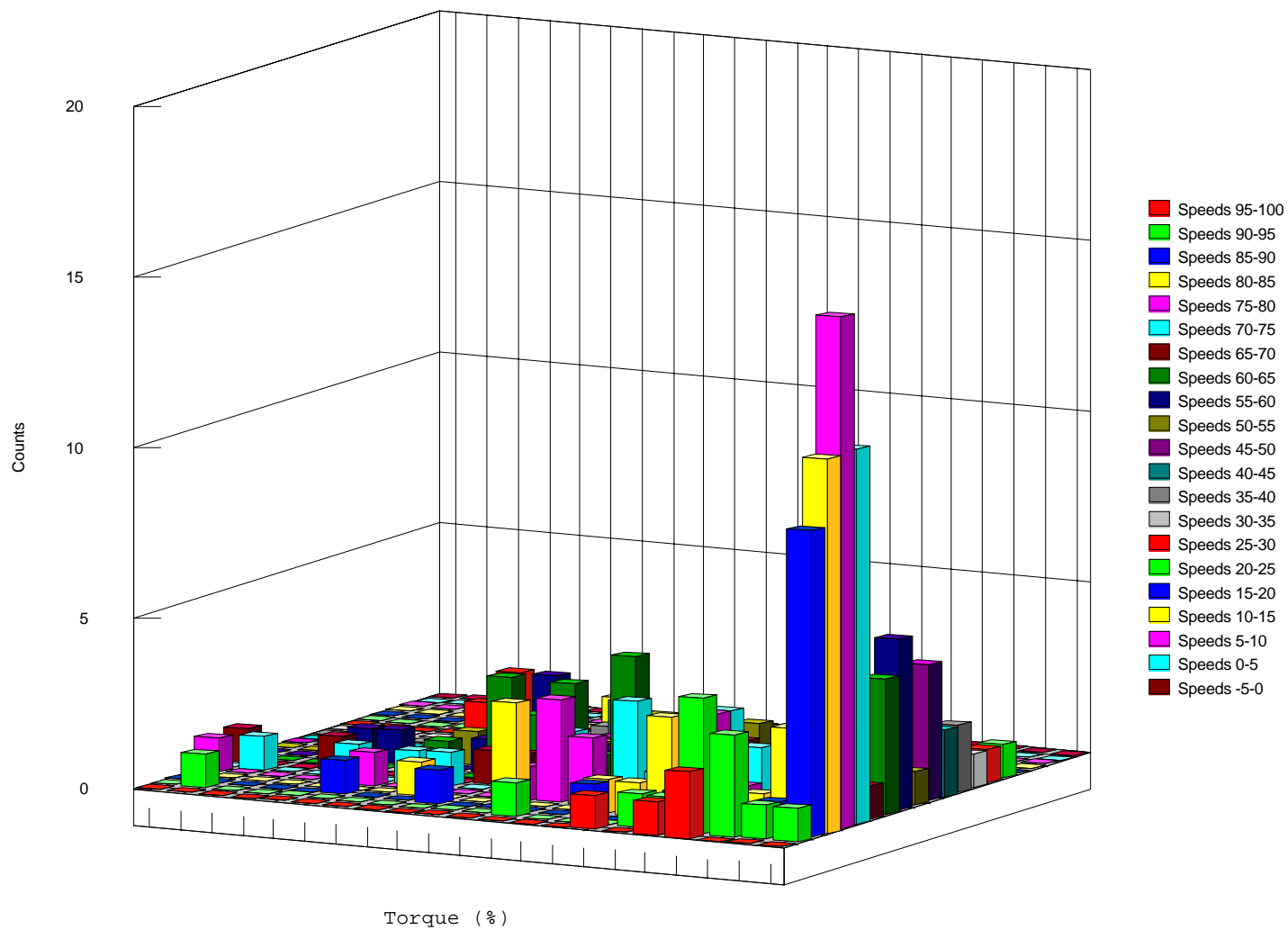


## Crawler--Mean Torque Changes

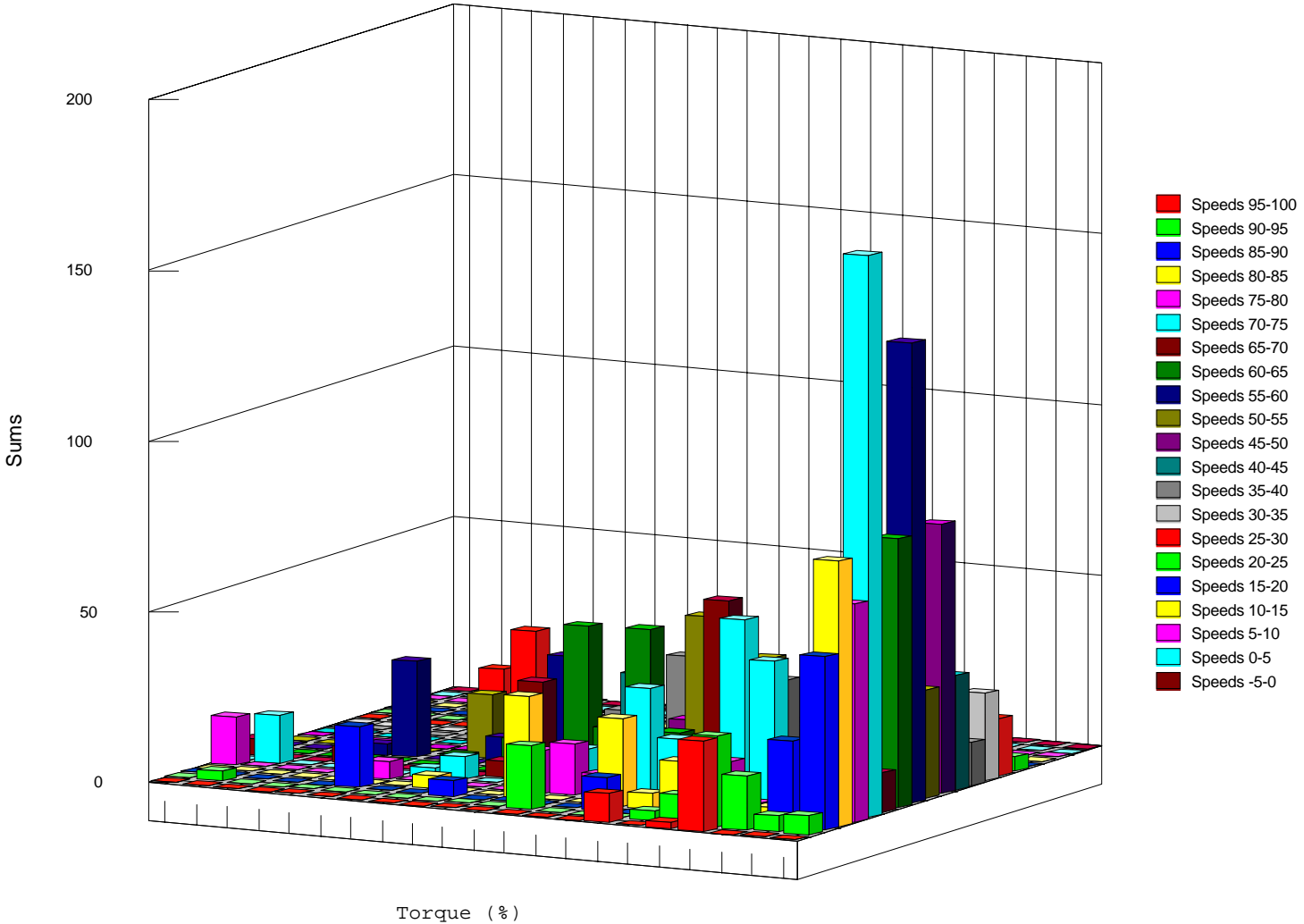




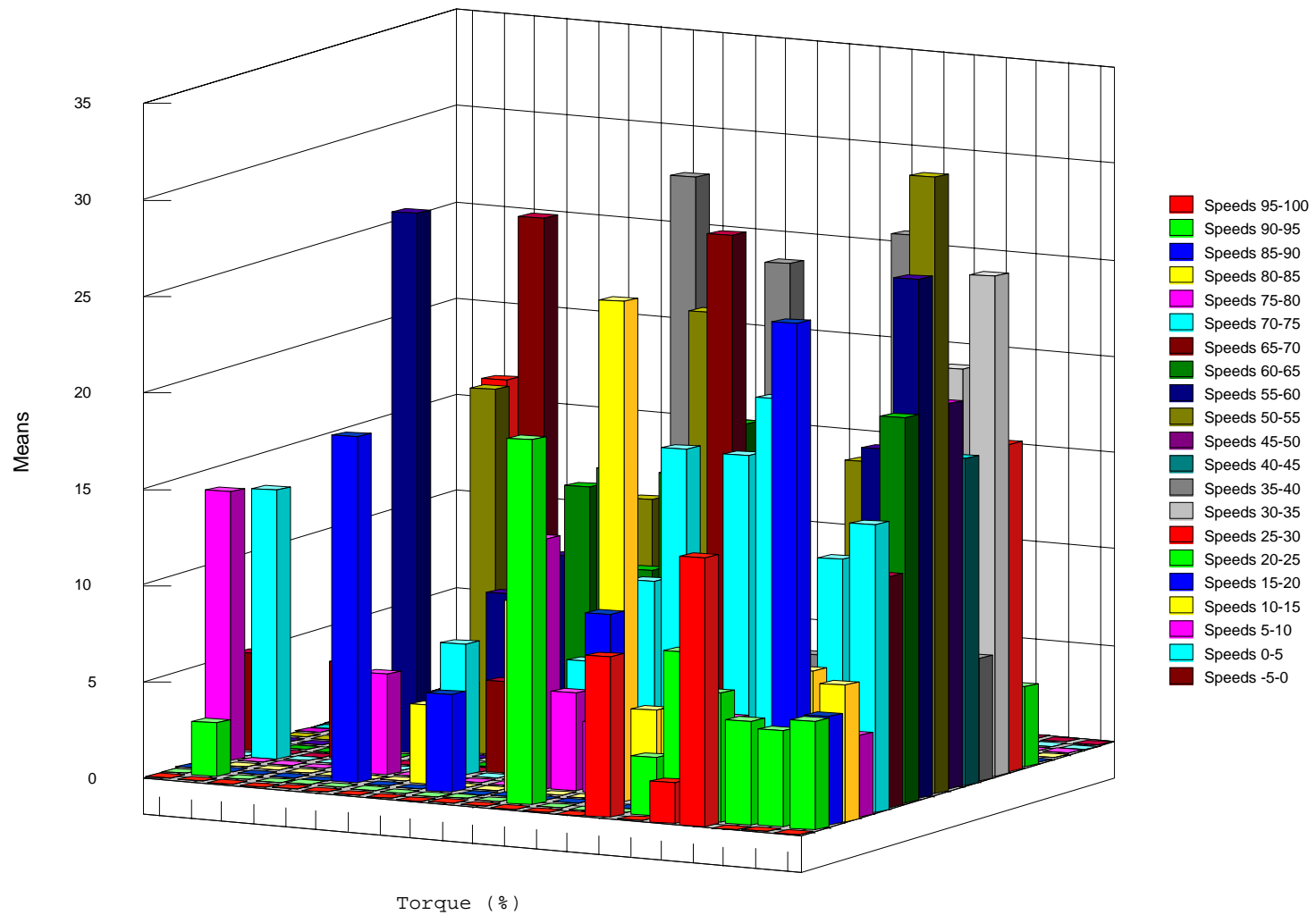
# Crawler--Speed Acceleration Counts

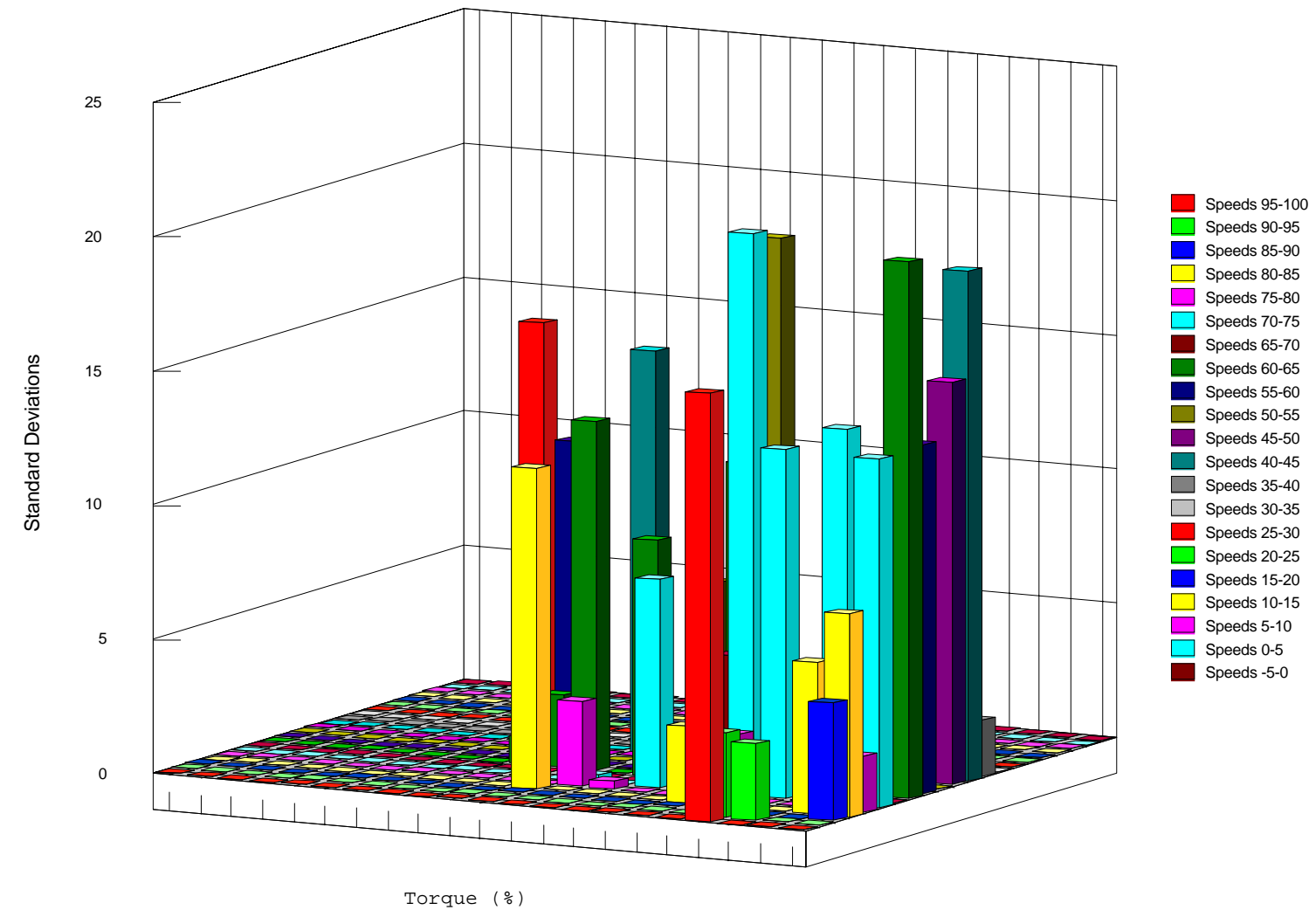


## Crawler--Speed Acceleration Sums

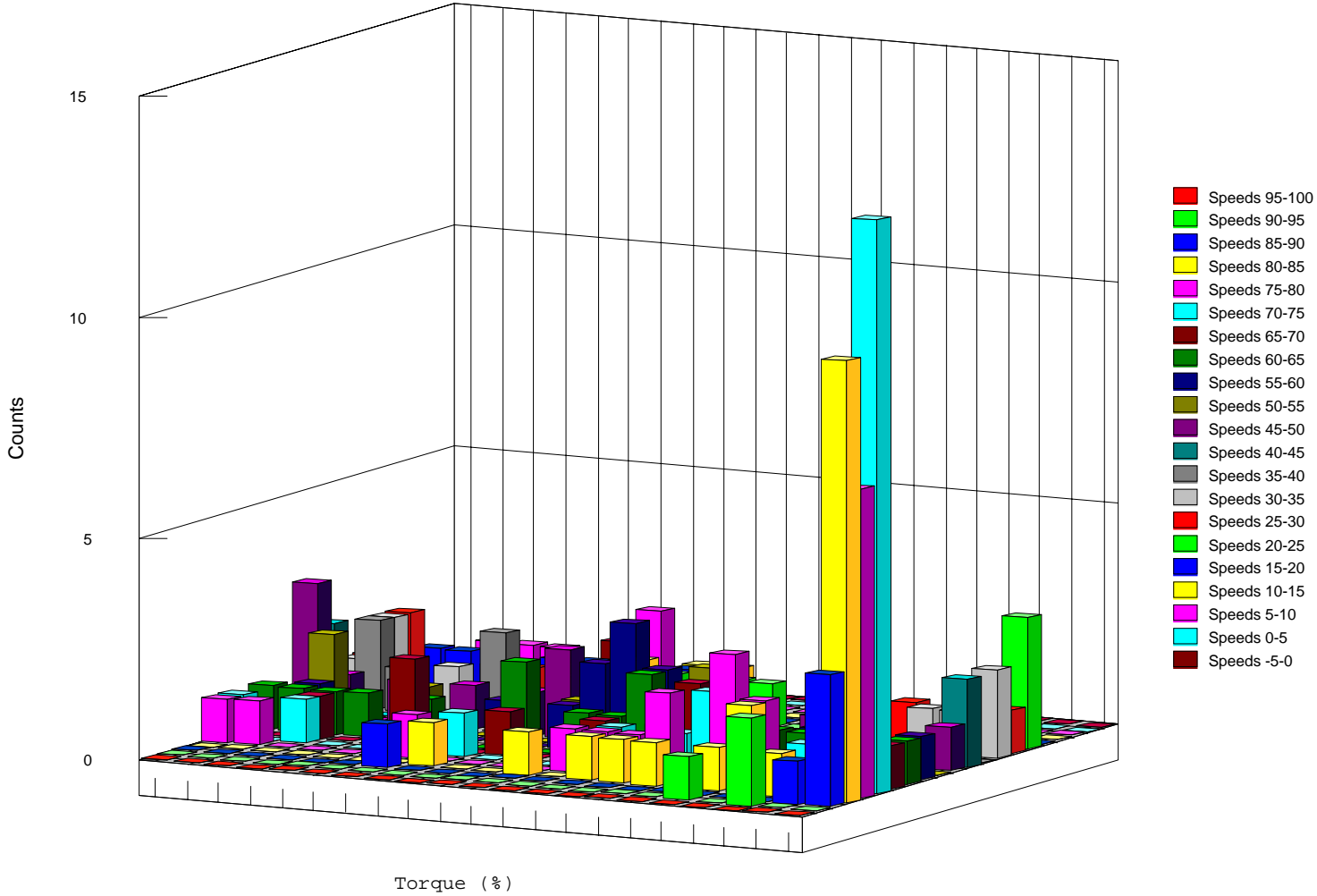


## Crawler--Speed Acceleration Means

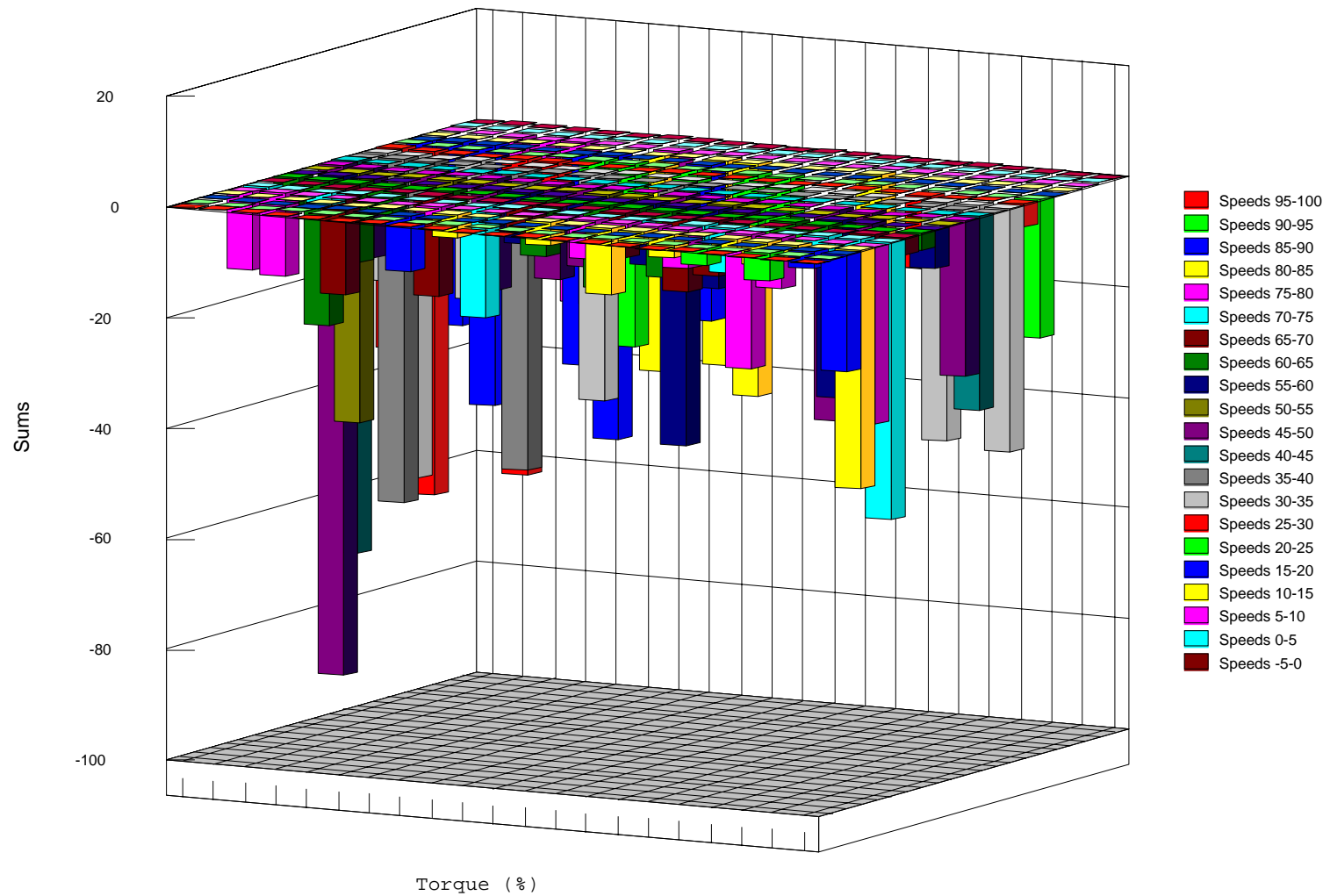


[illegible]

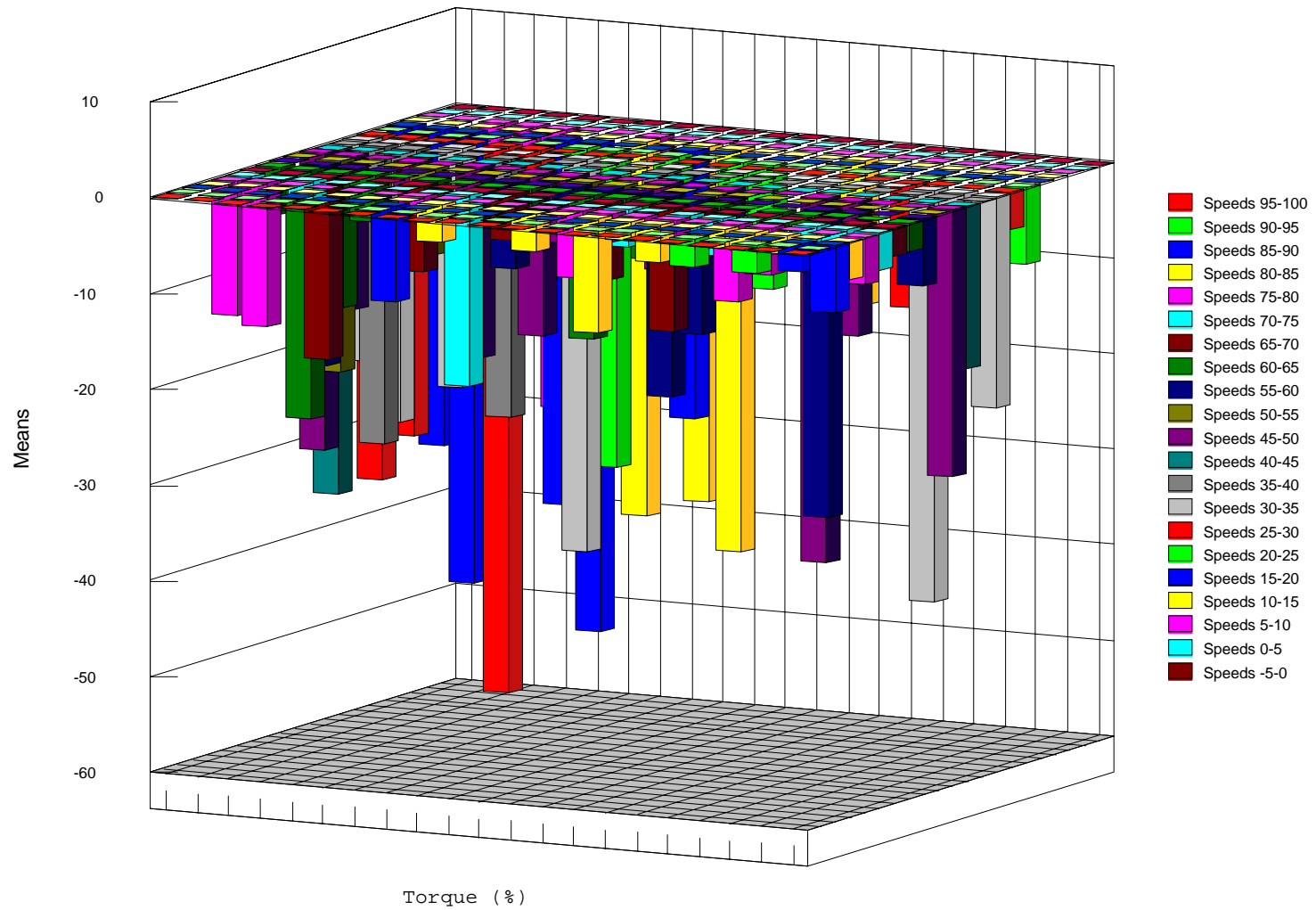
## Crawler--Speed Deceleration Counts



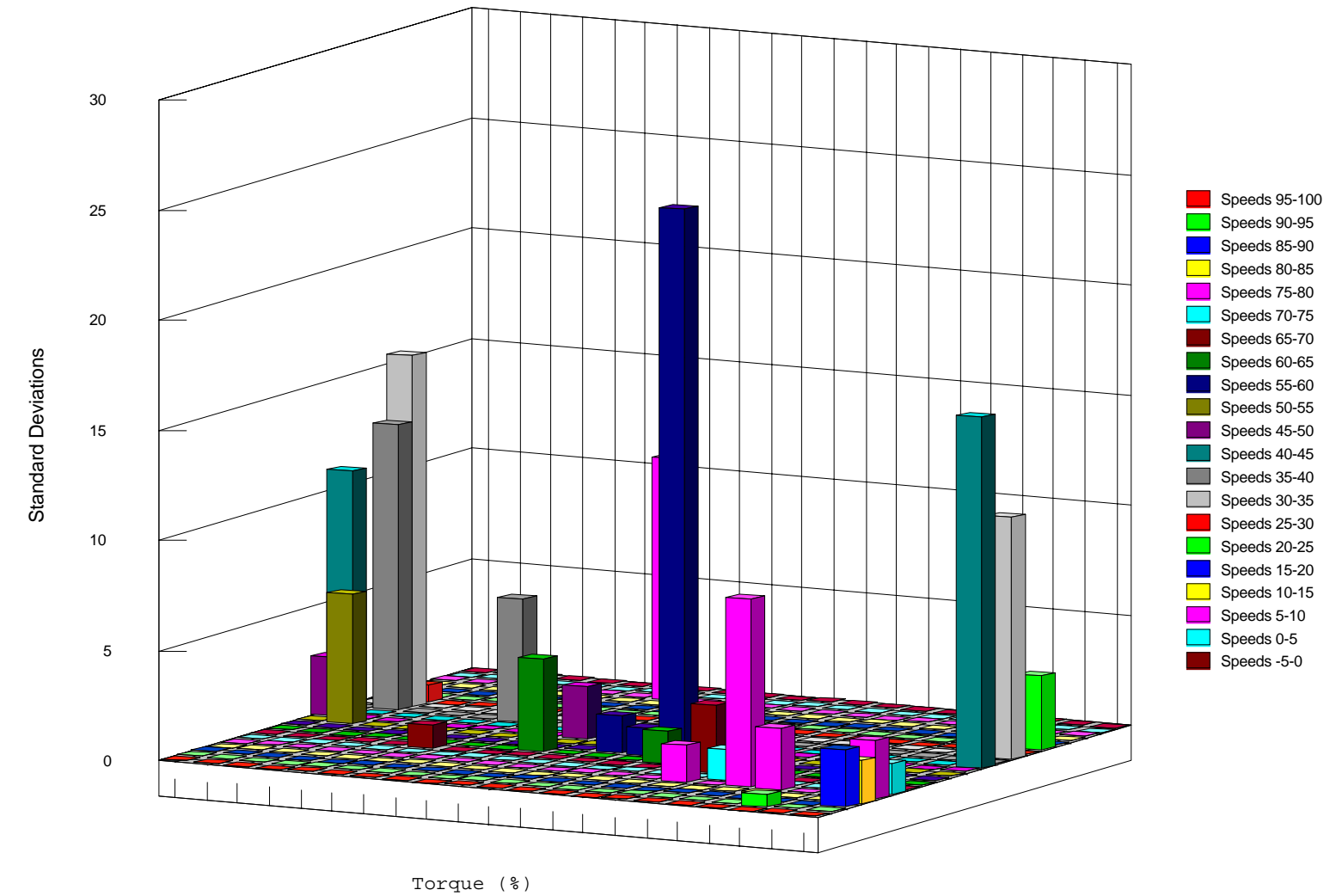
## Crawler--Speed Deceleration Sums



## Crawler--Speed Deceleration Means

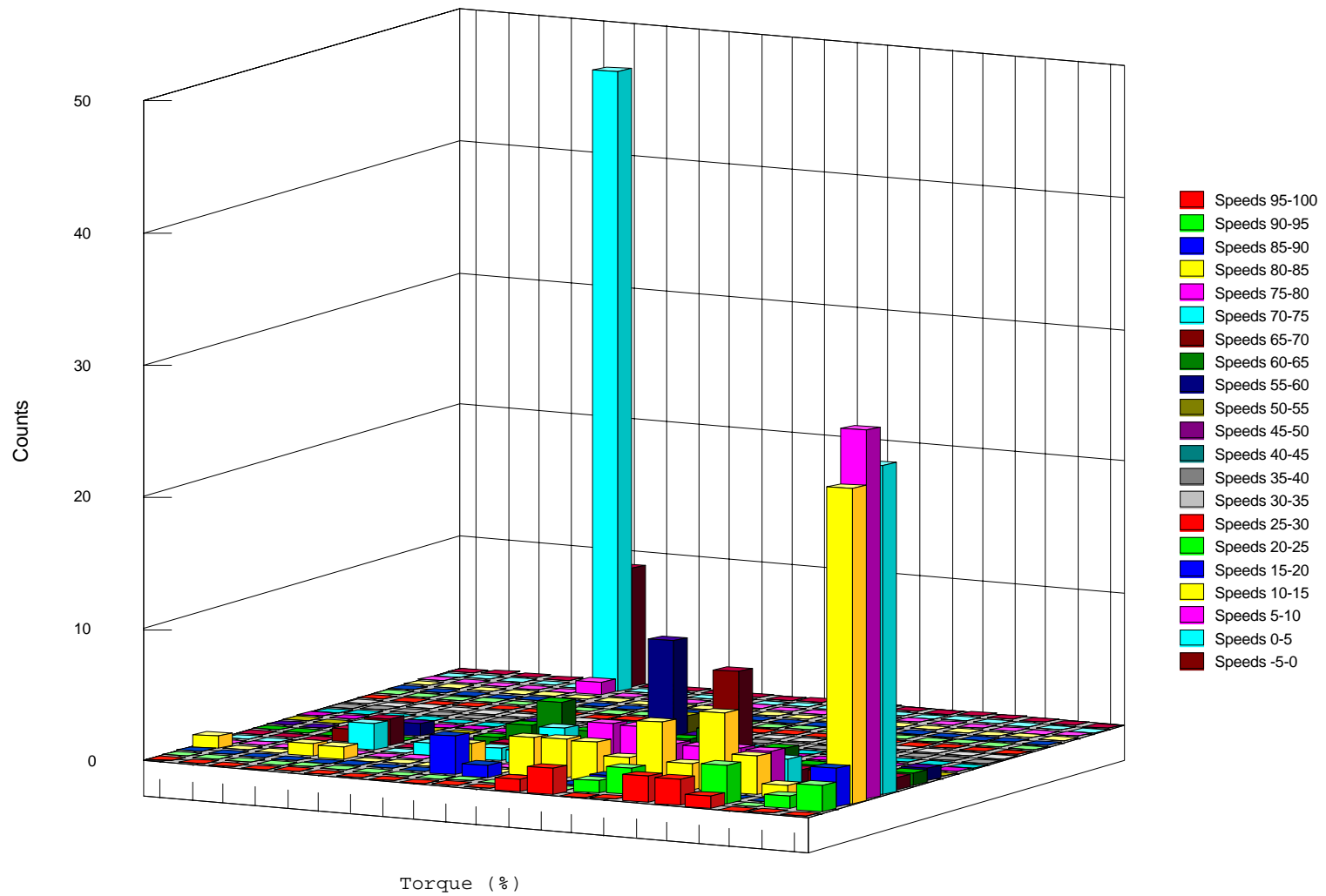


Crawler--Speed Deceleration Std. Deviations	
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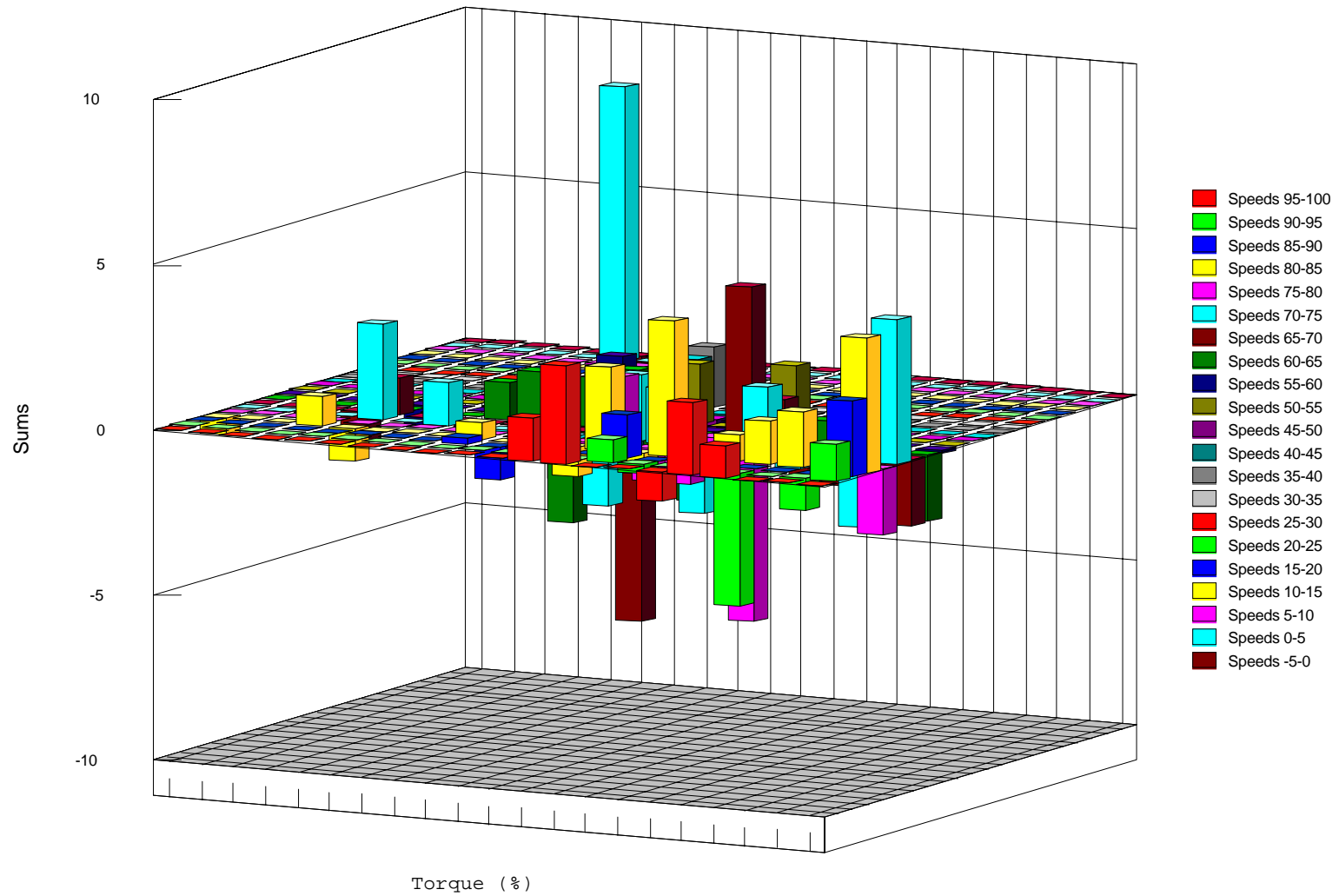




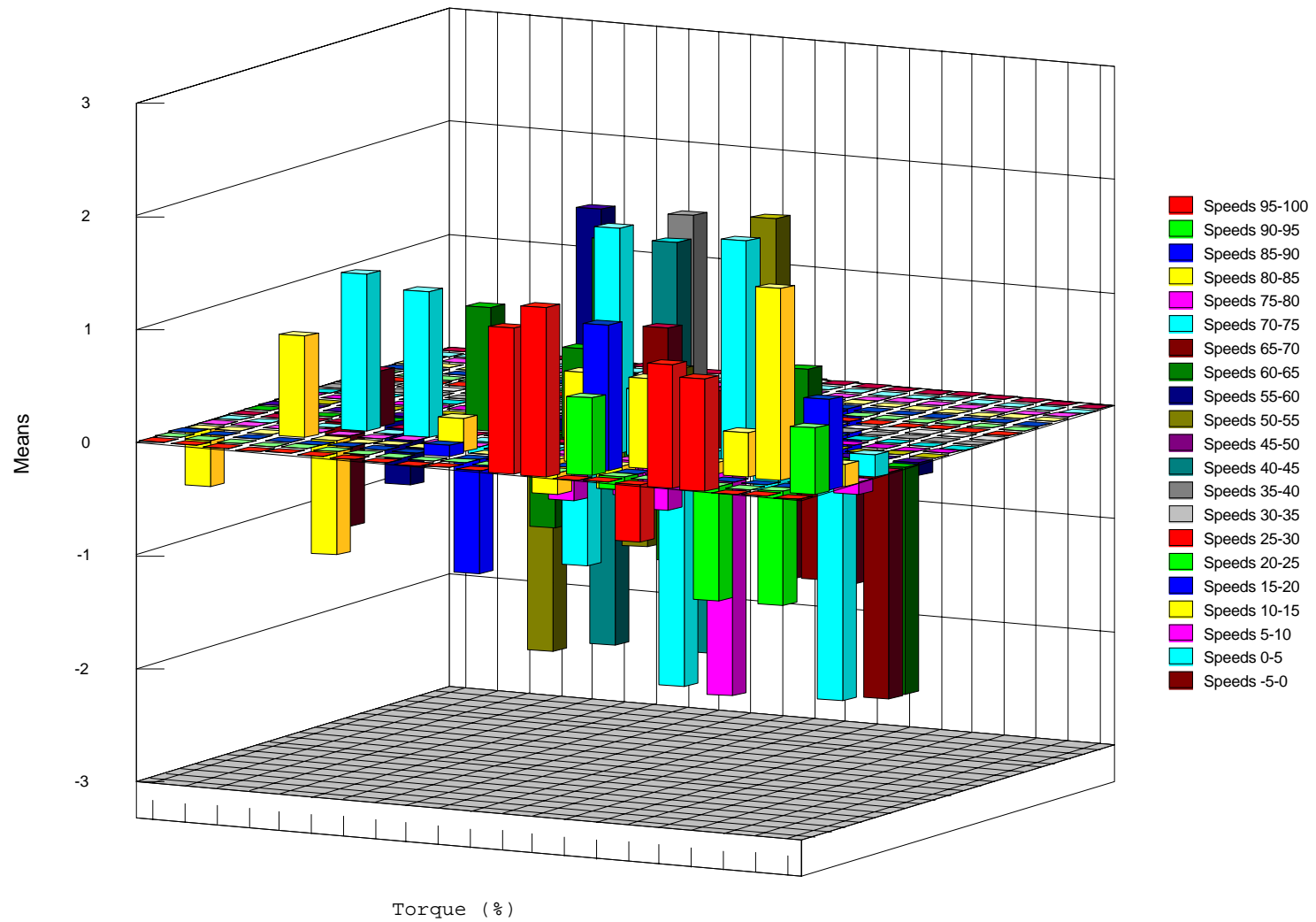
## Crawler--Speed Steady State Counts



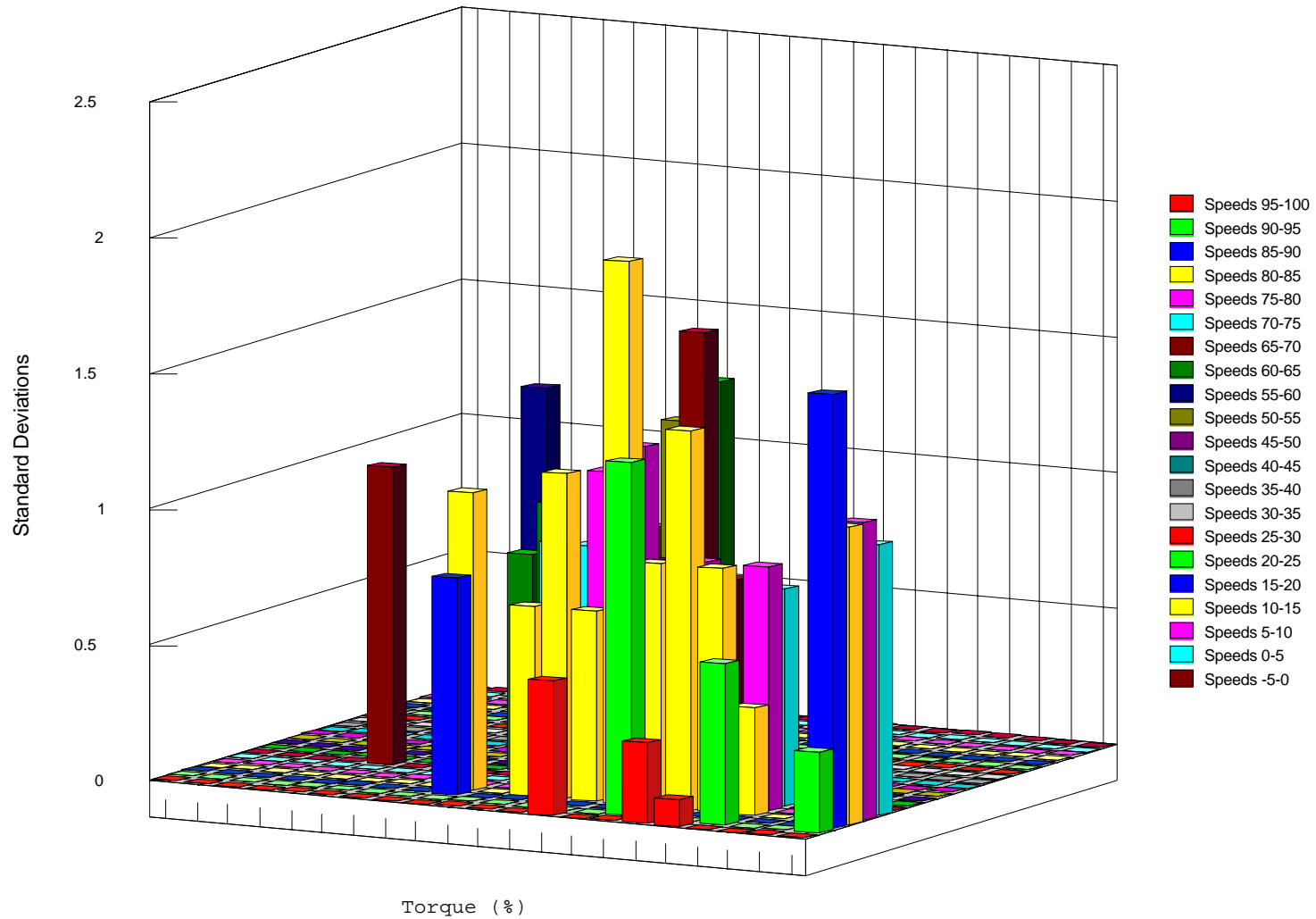
## Crawler--Speed Steady State Sums



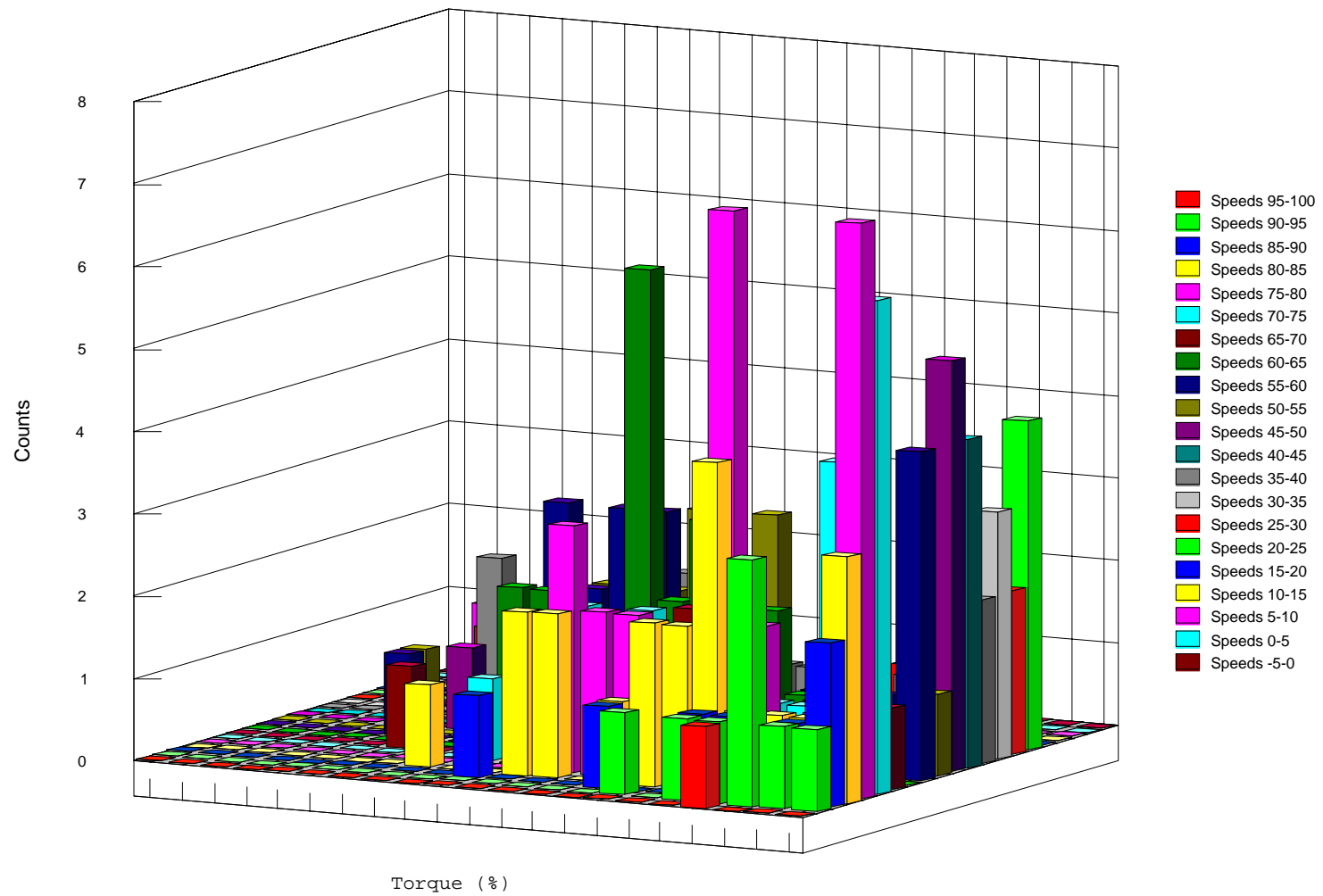
## Crawler--Speed Steady State Means



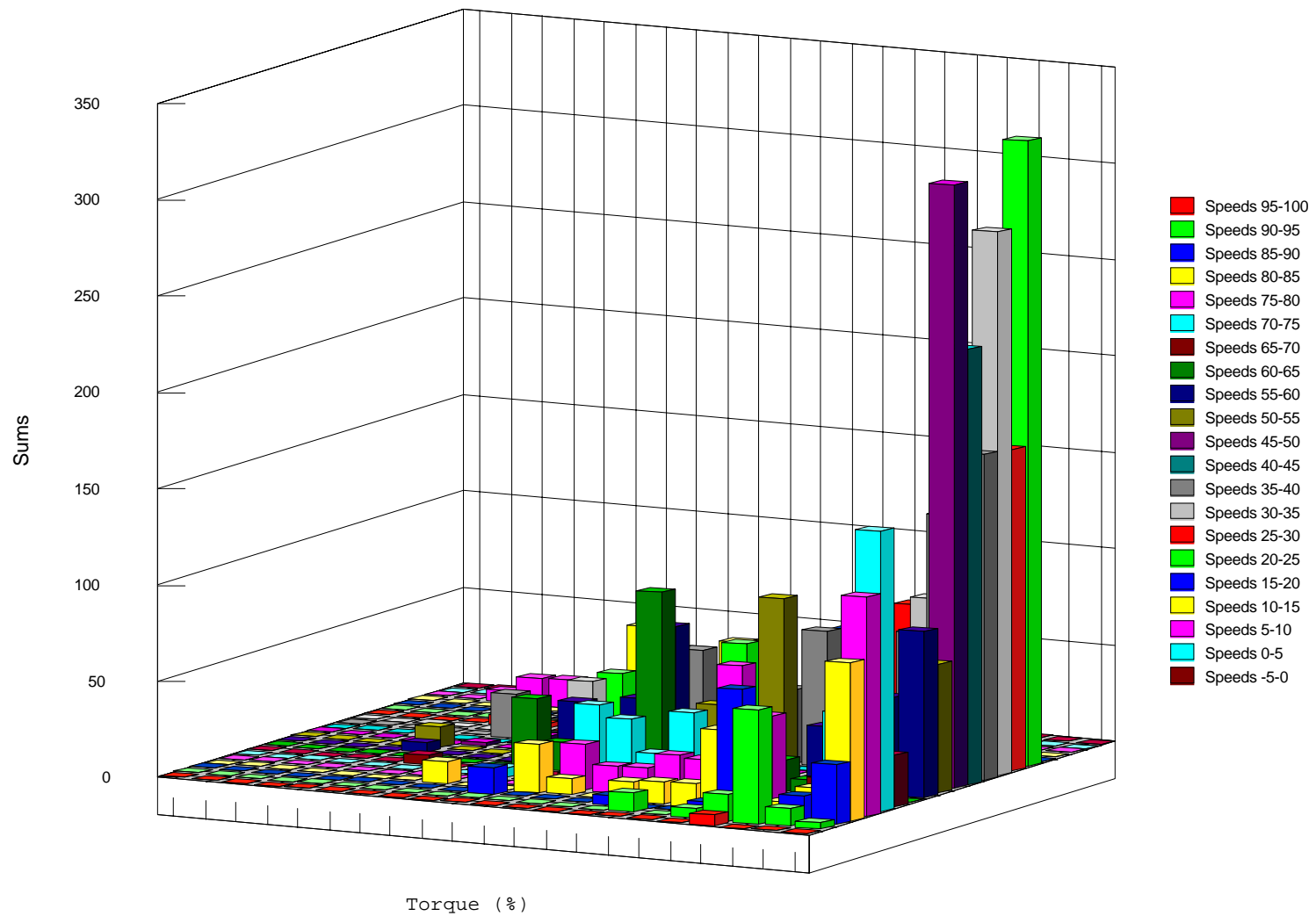
## Crawler--Steady State Std. Deviations



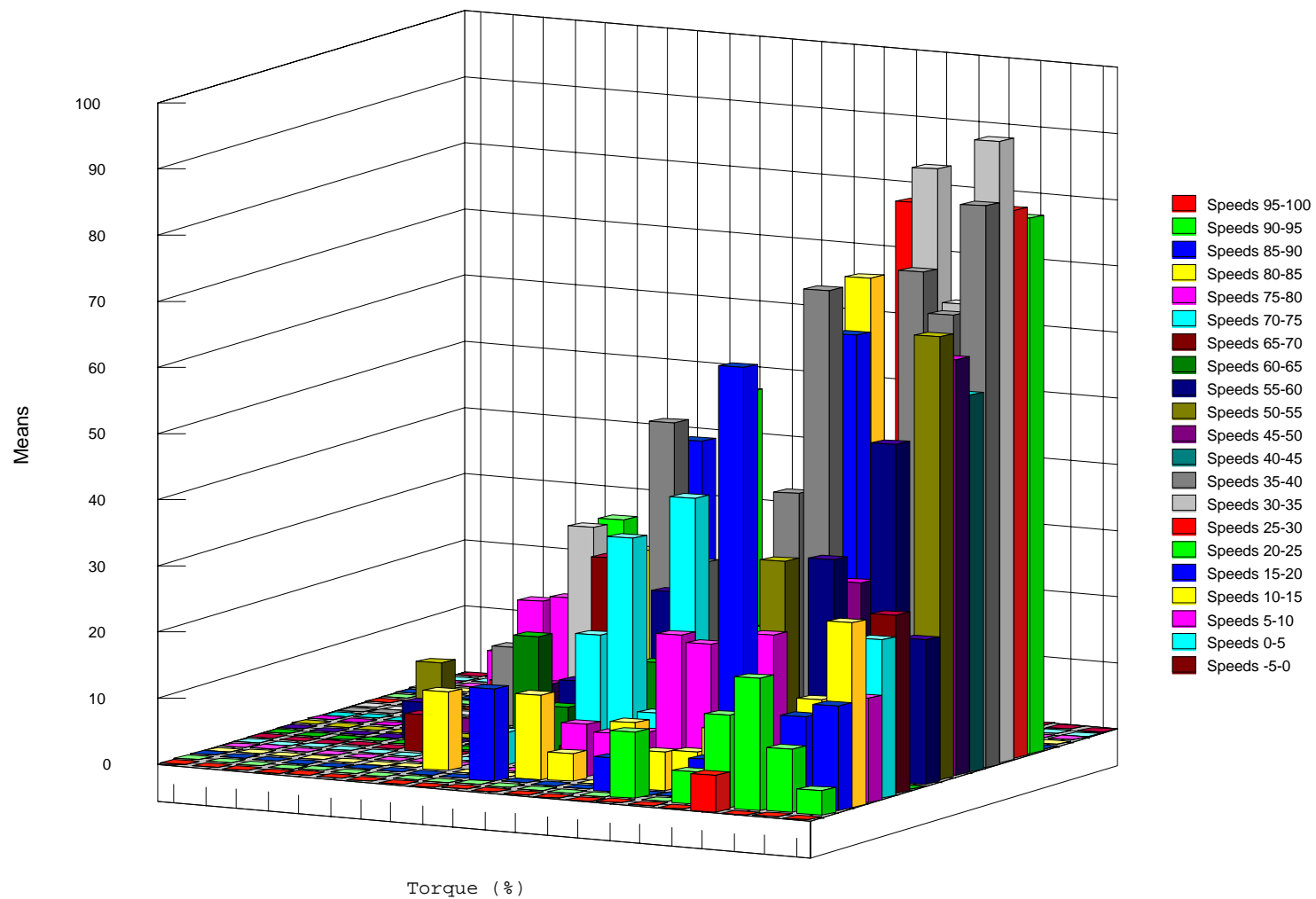
## Crawler--Torque Acceleration Counts

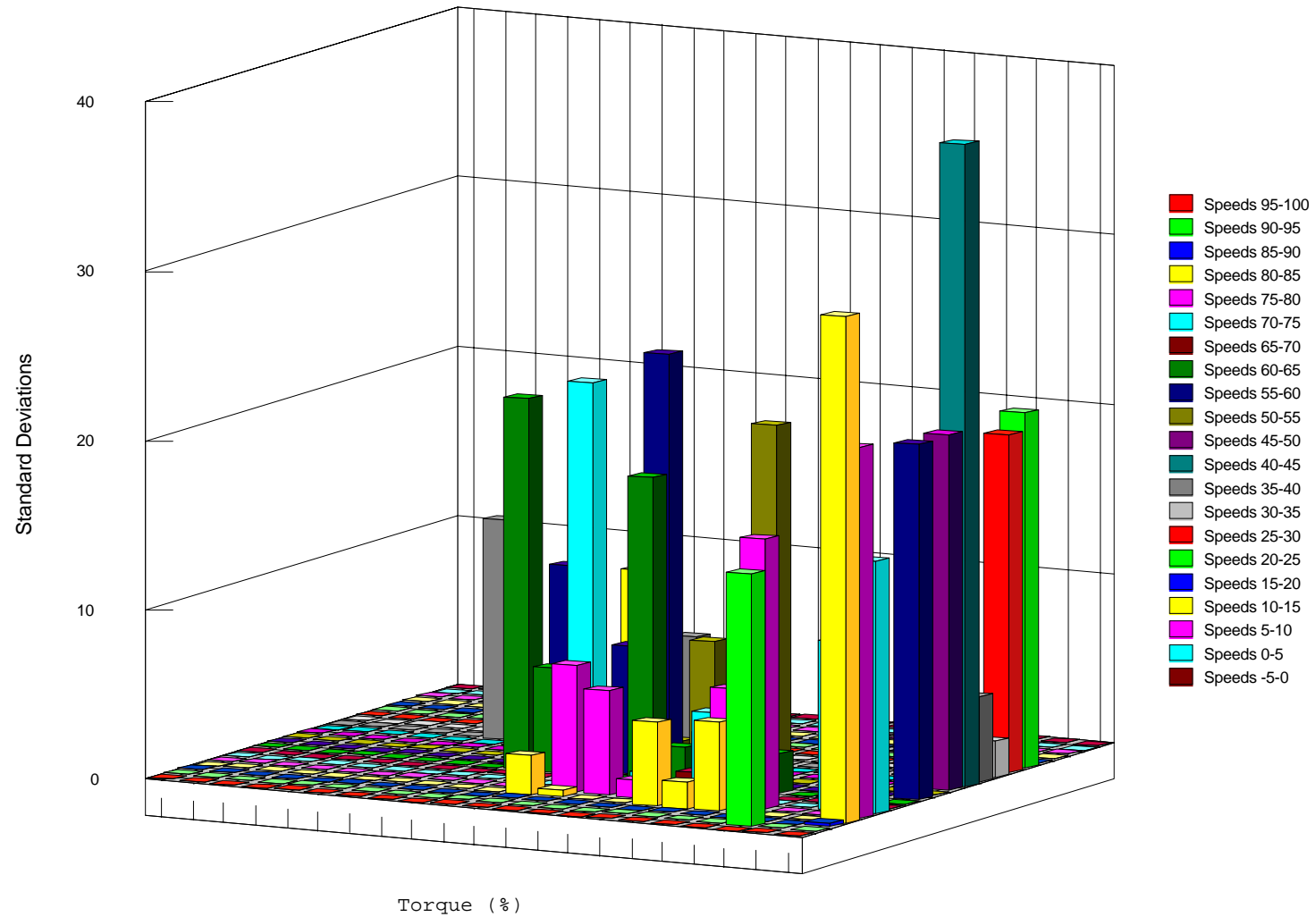


## Crawler--Torque Acceleration Sums



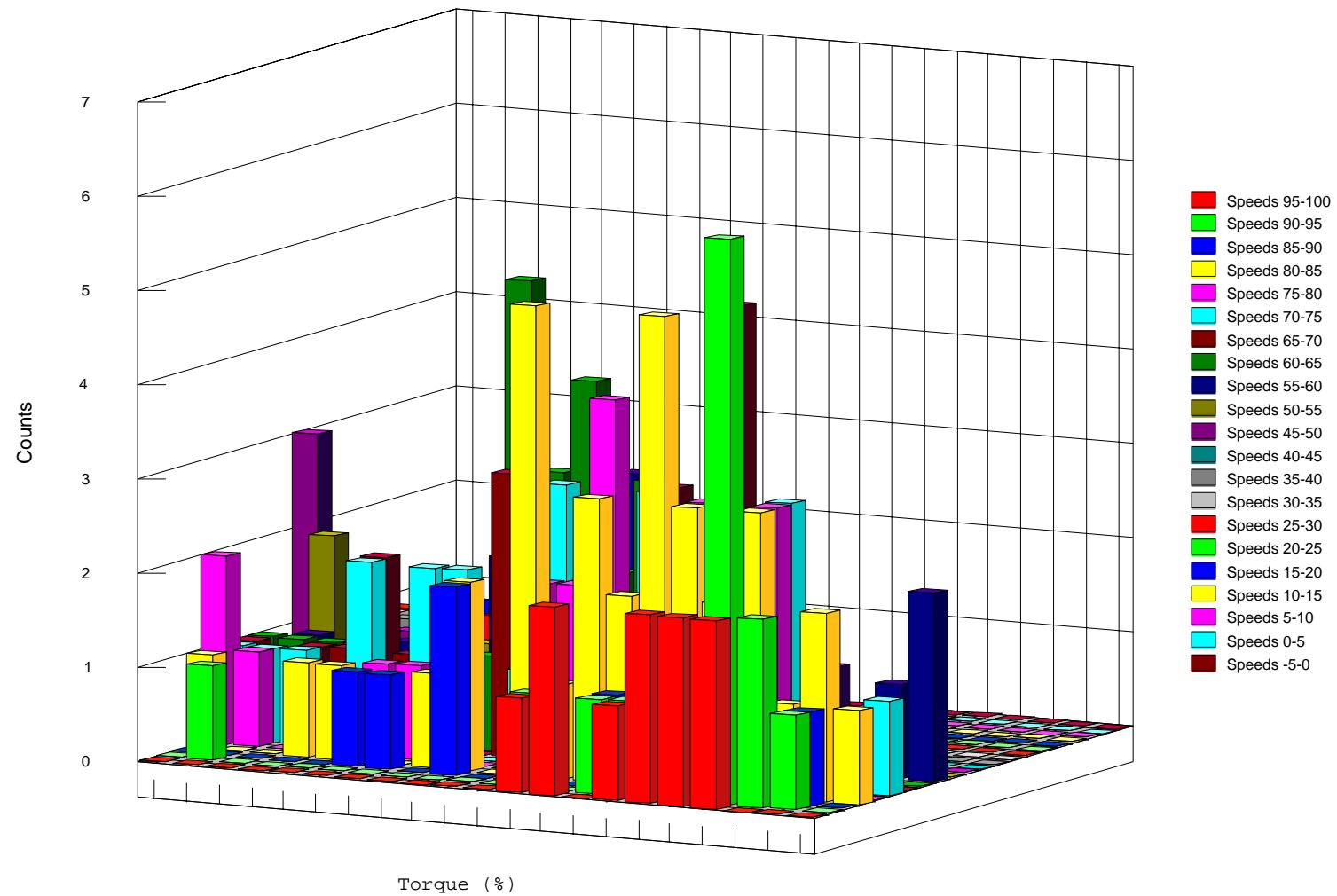
Crawler--Torque Acceleration Means	
1	1.0
2	2.0
3	3.0
4	4.0
5	5.0
6	6.0
7	7.0
8	8.0
9	9.0
10	10.0
11	11.0
12	12.0
13	13.0
14	14.0
15	15.0
16	16.0
17	17.0
18	18.0
19	19.0
20	20.0
21	21.0
22	22.0
23	23.0
24	24.0
25	25.0
26	26.0
27	27.0
28	28.0
29	29.0
30	30.0
31	31.0
32	32.0
33	33.0
34	34.0
35	35.0
36	36.0
37	37.0
38	38.0
39	39.0
40	40.0
41	41.0
42	42.0
43	43.0
44	44.0
45	45.0
46	46.0
47	47.0
48	48.0
49	49.0
50	50.0
51	51.0
52	52.0
53	53.0
54	54.0
55	55.0
56	56.0
57	57.0
58	58.0
59	59.0
60	60.0
61	61.0
62	62.0
63	63.0
64	64.0
65	65.0
66	66.0
67	67.0
68	68.0
69	69.0
70	70.0
71	71.0
72	72.0
73	73.0
74	74.0
75	75.0
76	76.0
77	77.0
78	78.0
79	79.0
80	80.0
81	81.0
82	82.0
83	83.0
84	84.0
85	85.0
86	86.0
87	87.0
88	88.0
89	89.0
90	90.0
91	91.0
92	92.0
93	93.0
94	94.0
95	95.0
96	96.0
97	97.0
98	98.0
99	99.0
100	100.0



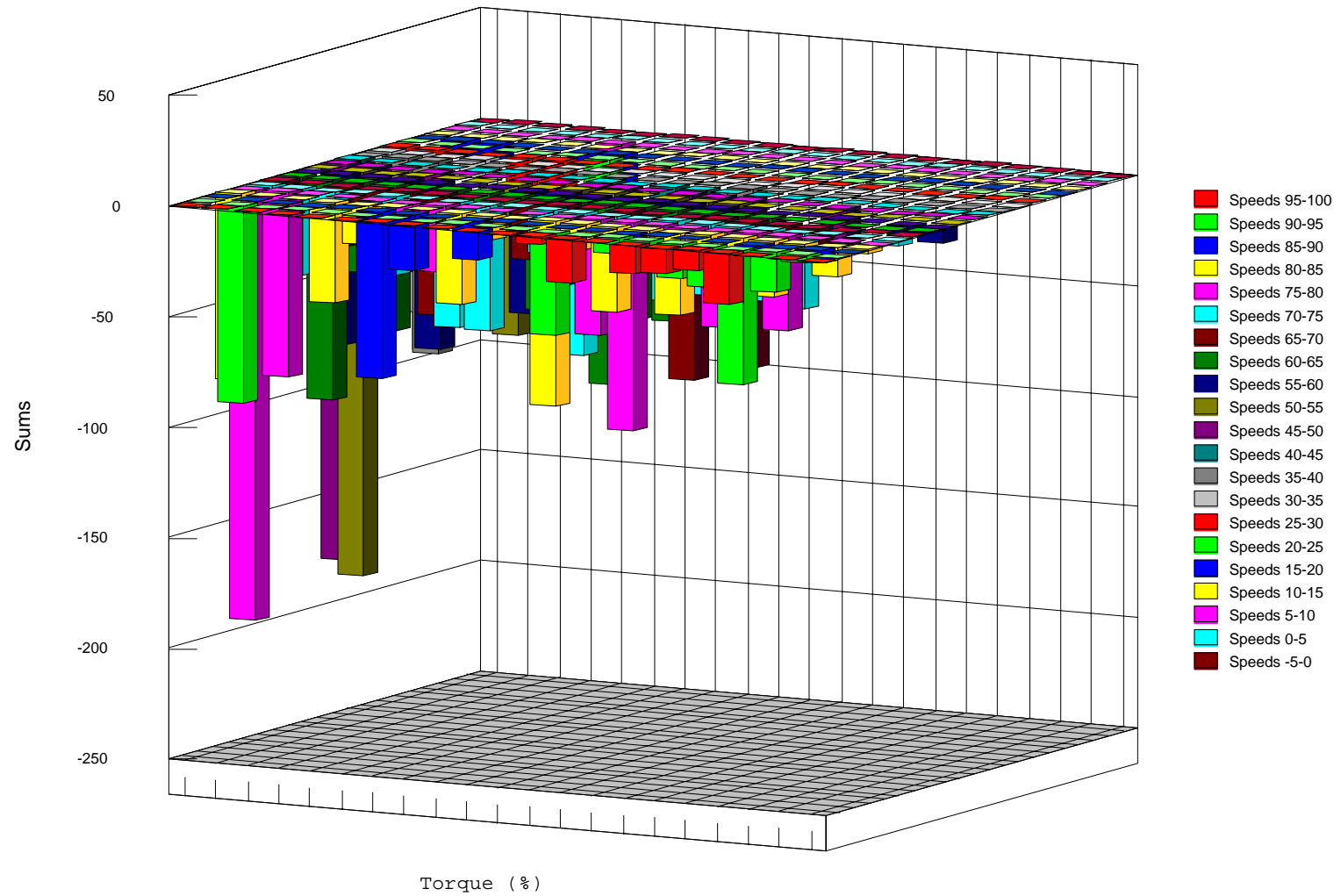
[illegible]



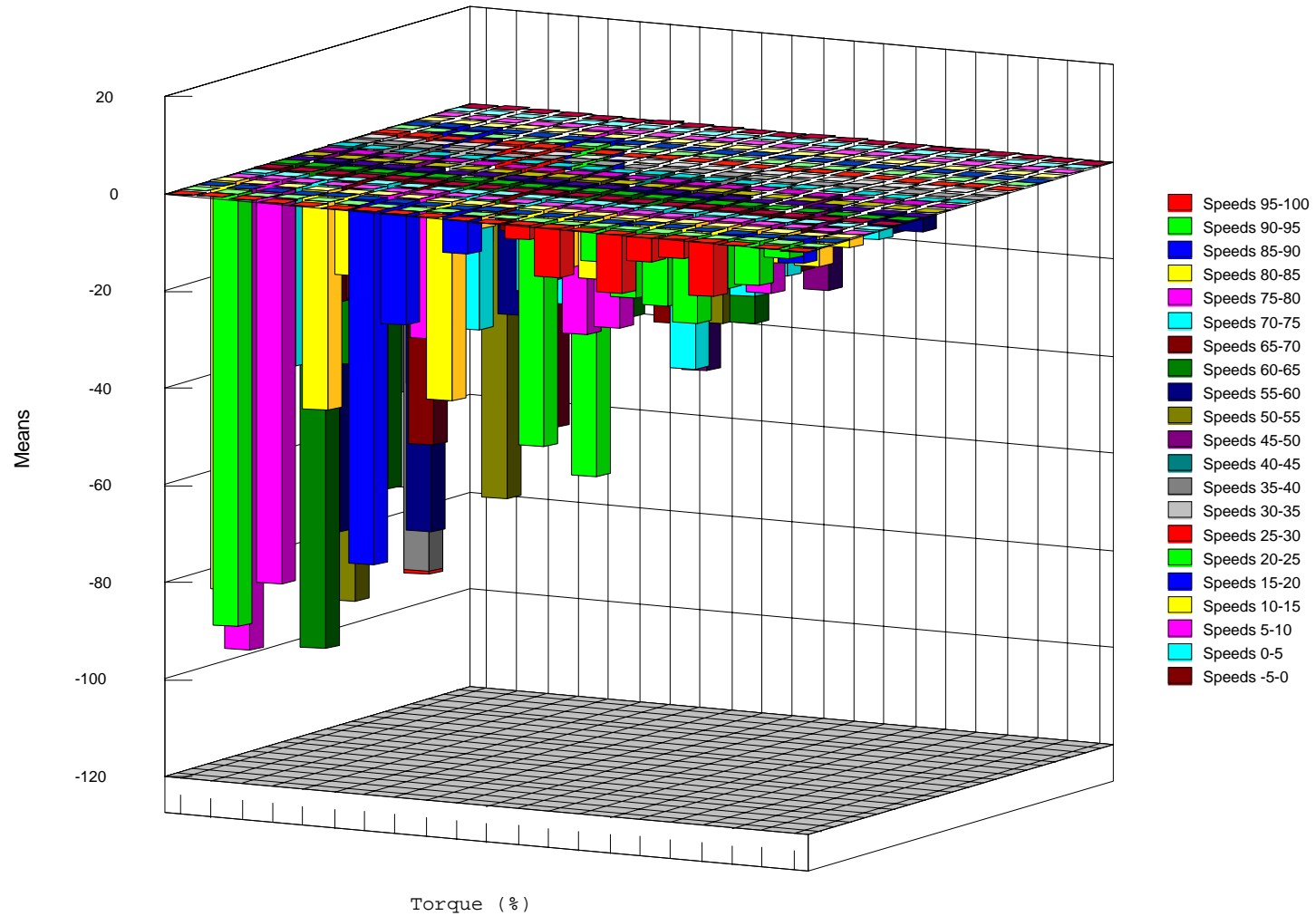
## Crawler--Torque Deceleration Counts



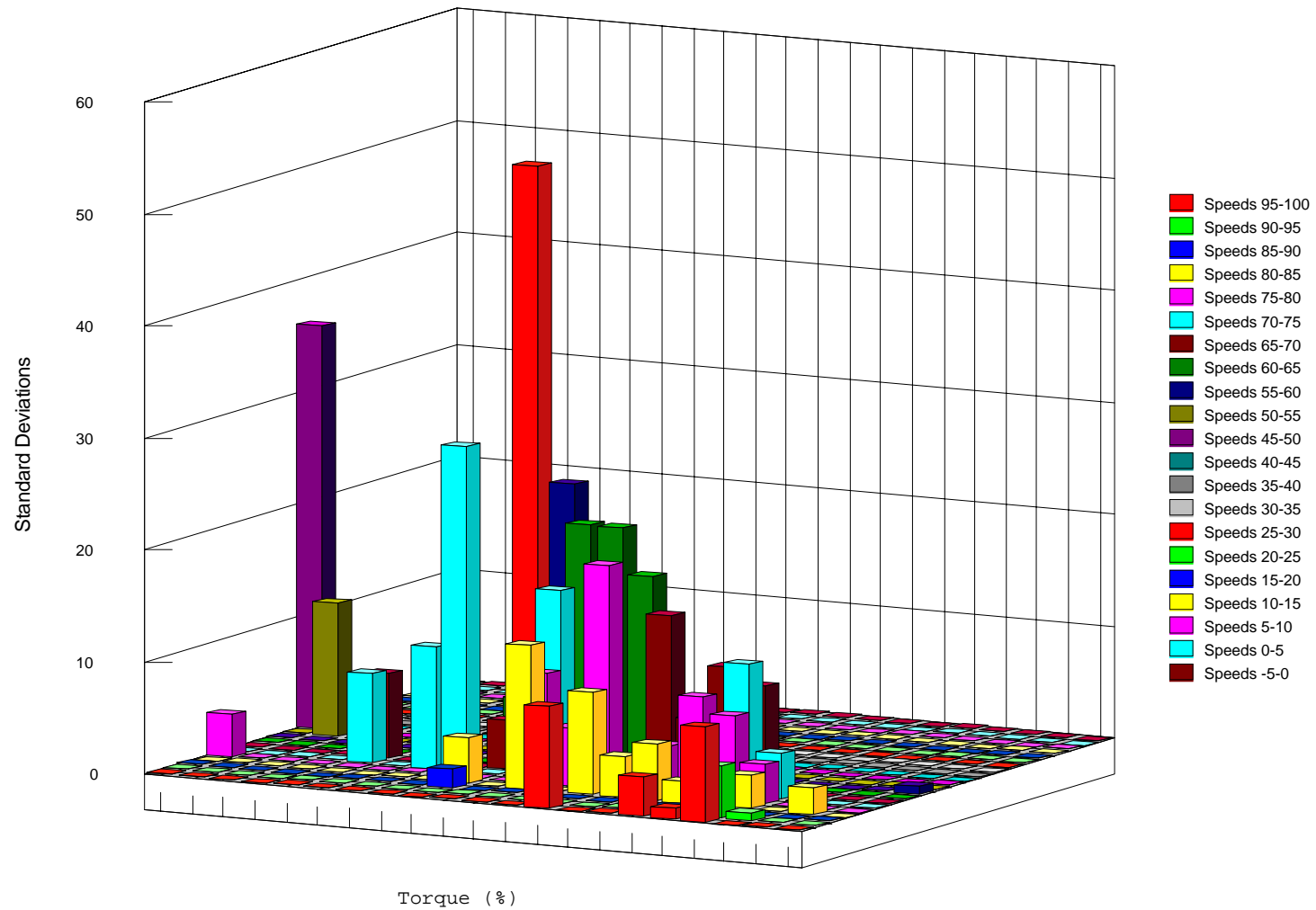
## Crawler--Torque Deceleration Sums



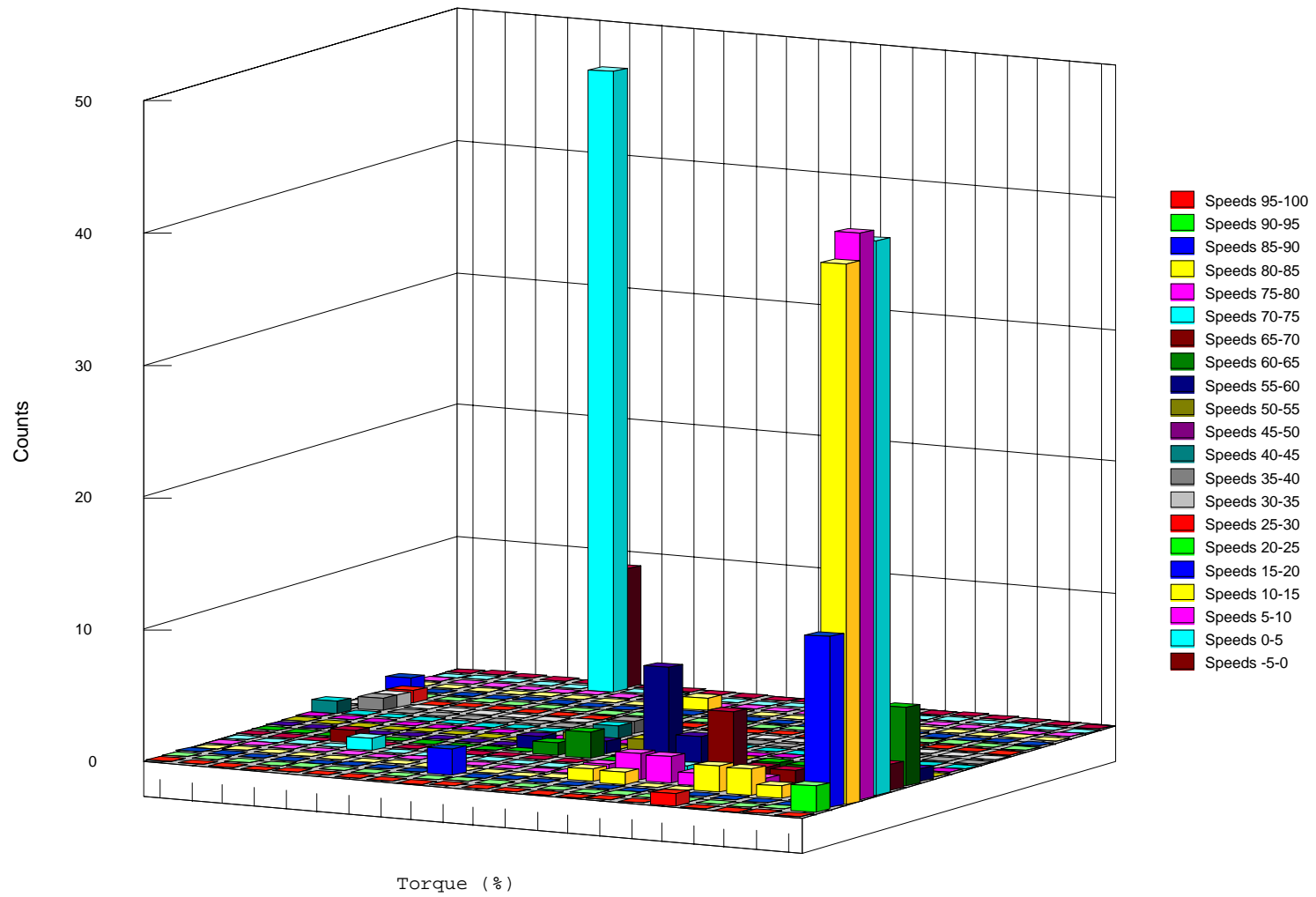
## Crawler--Torque Deceleration Means



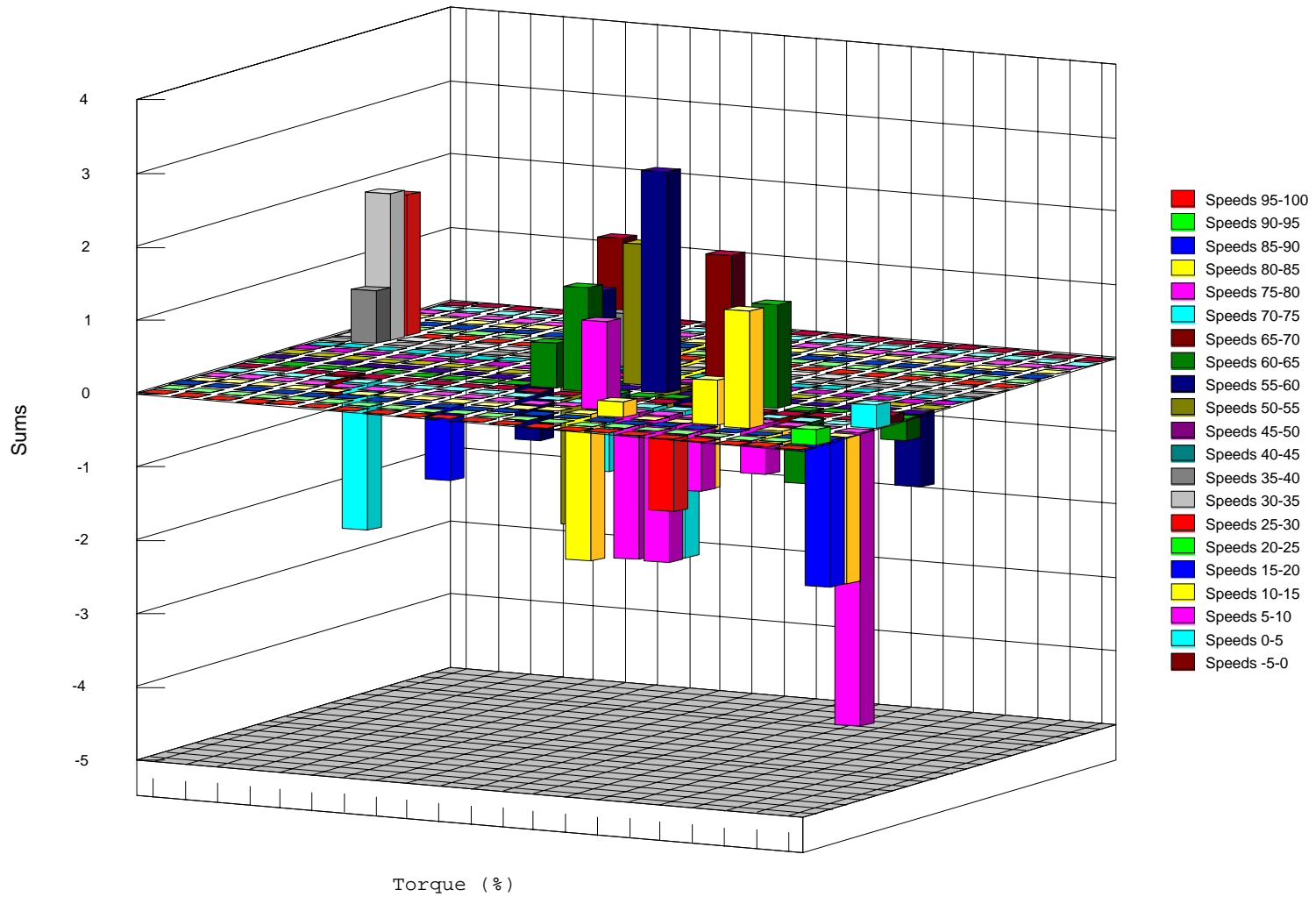
## Crawler--Torque Deceleration Std. Deviations



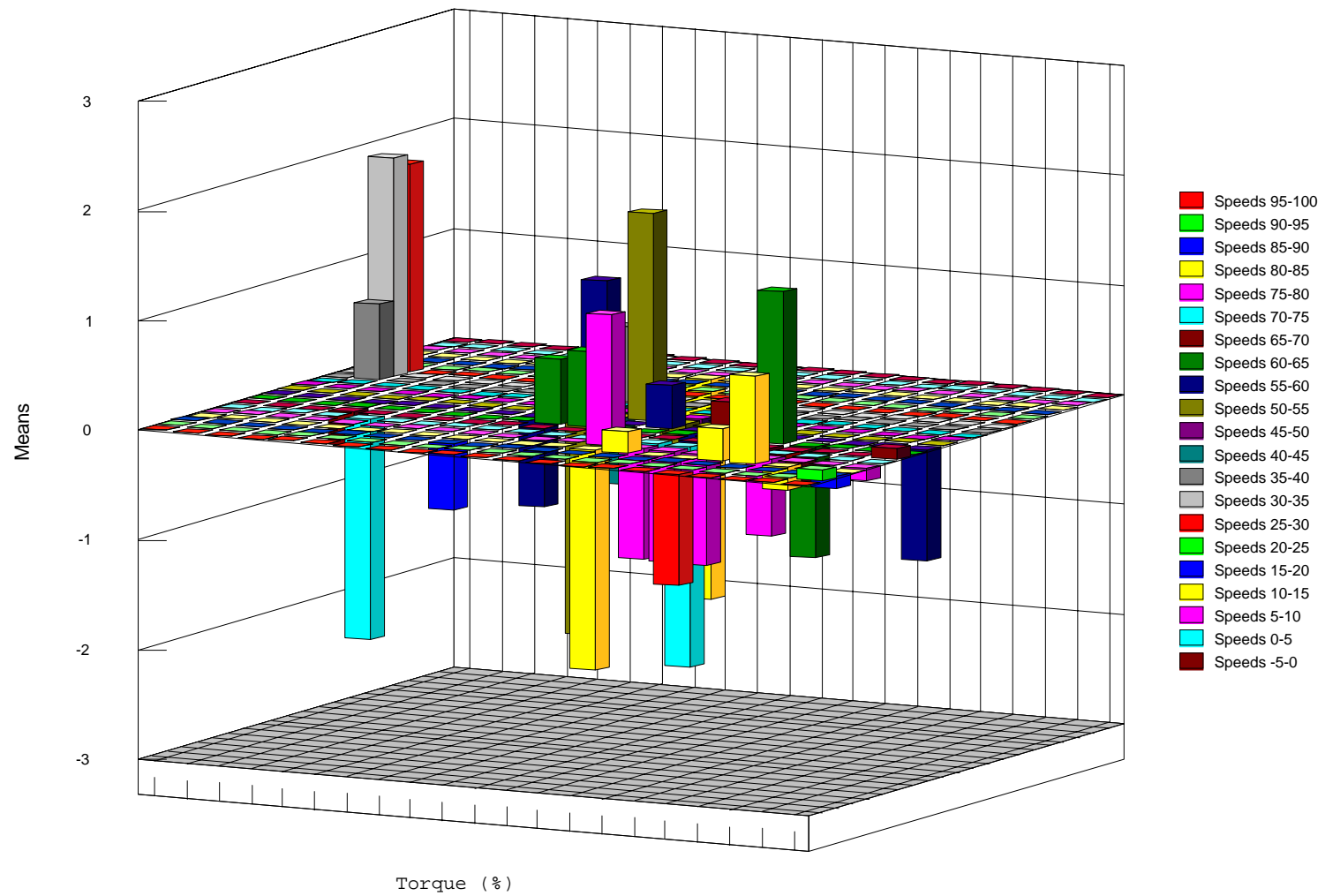
## Crawler--Torque Steady State Counts



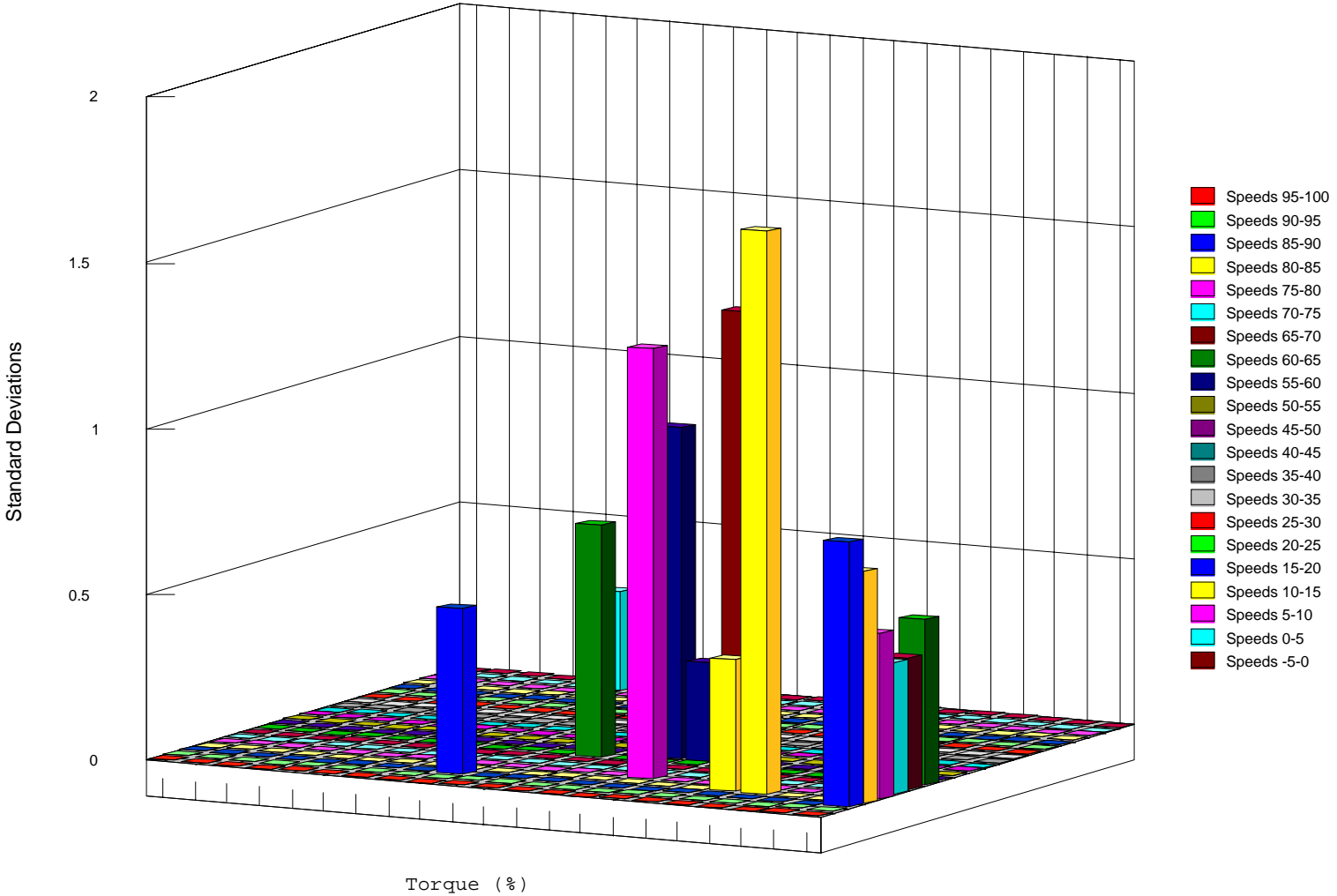
## Crawler--Torque Steady State Sums



## Crawler--Torque Steady State Means

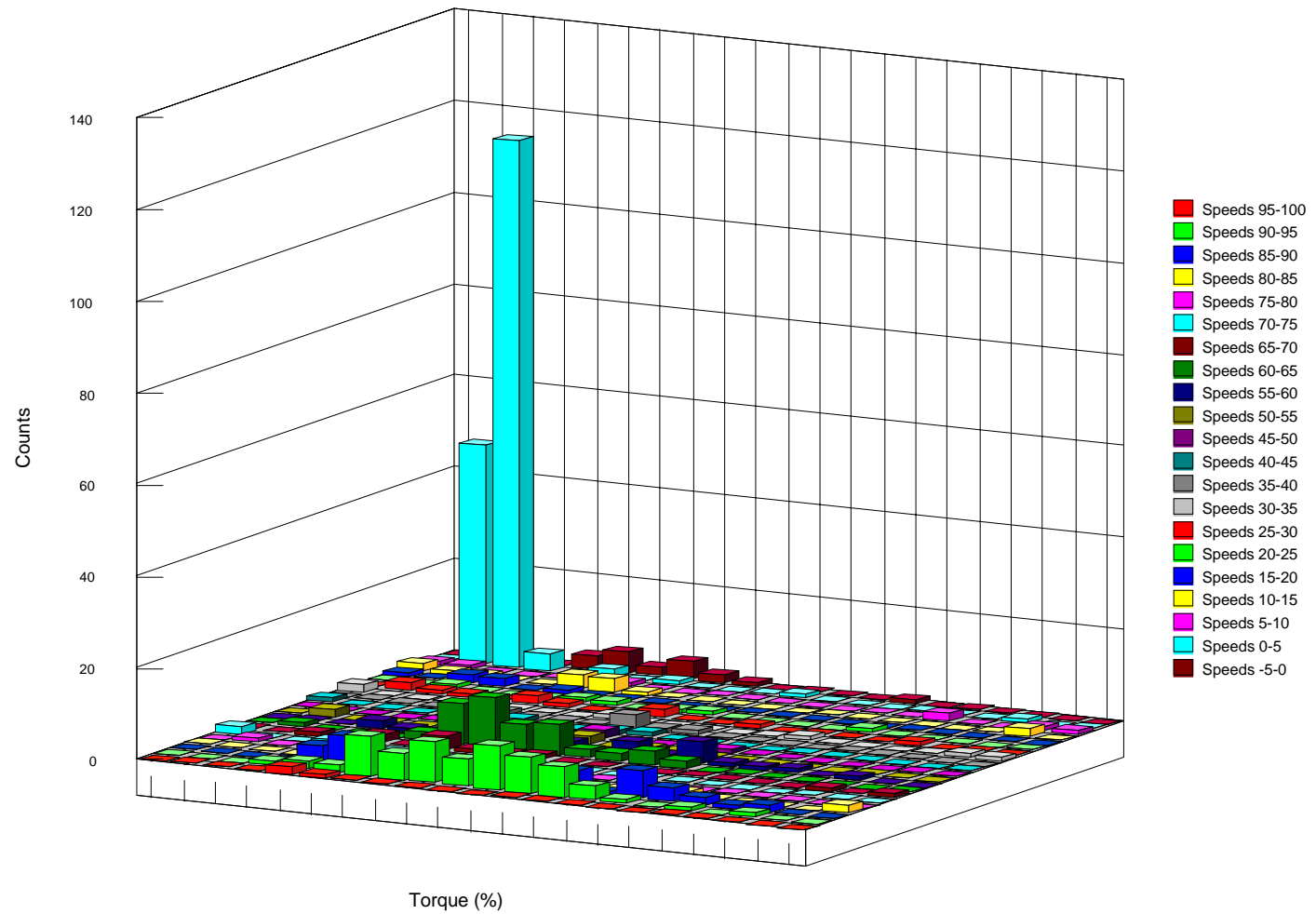


Crawler--Torque Steady State Std. Deviations	
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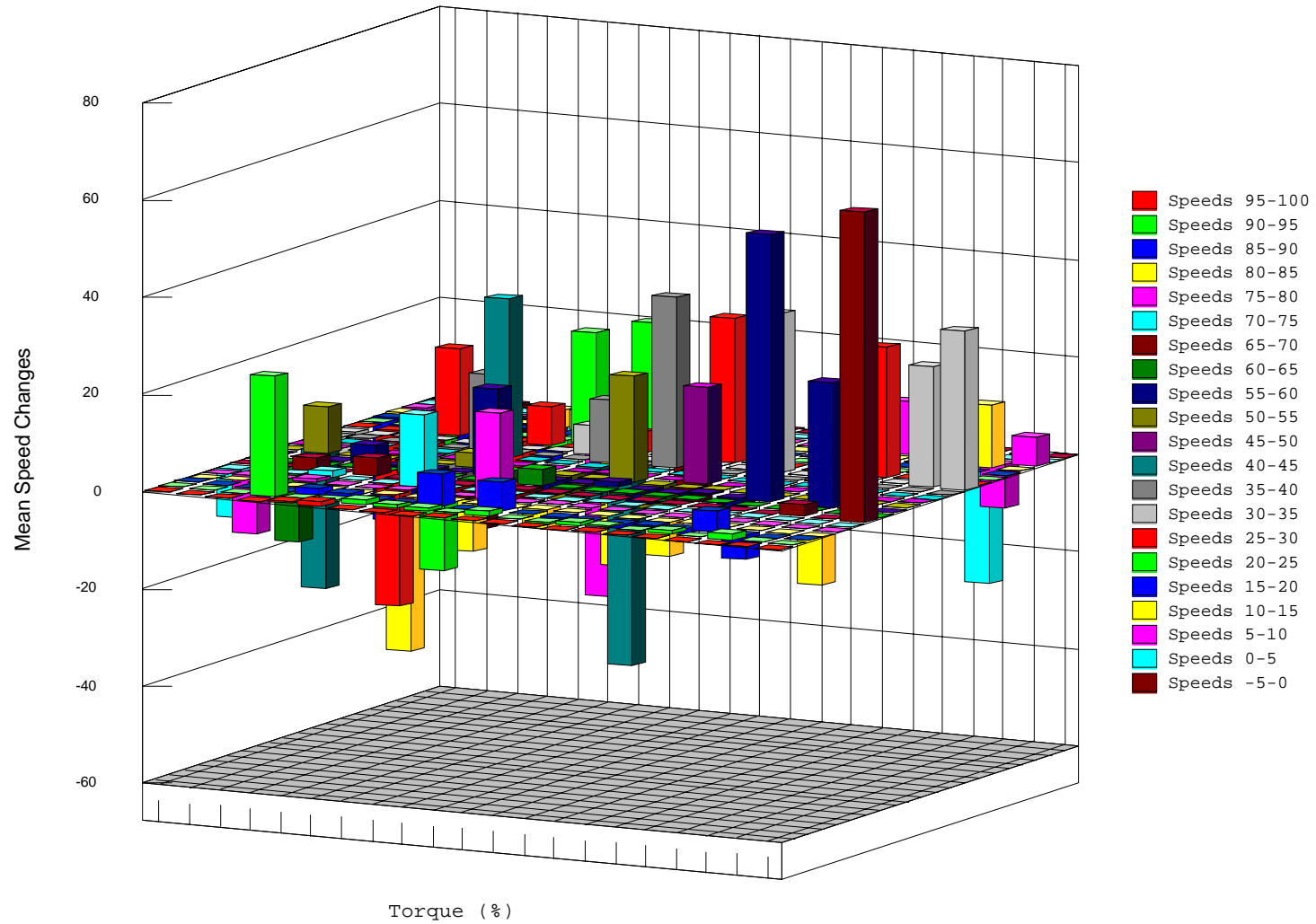




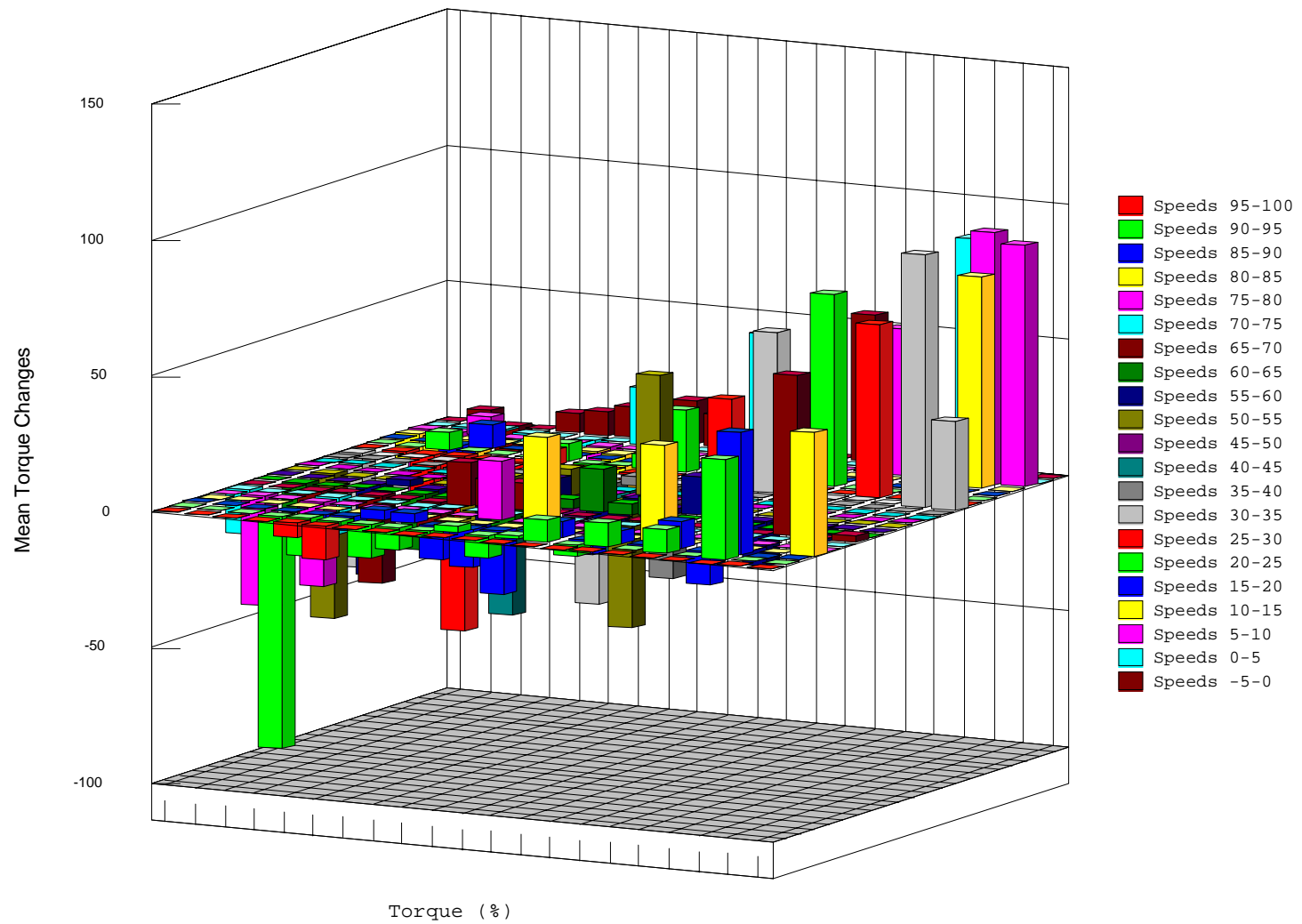
## Backhoe--Counts



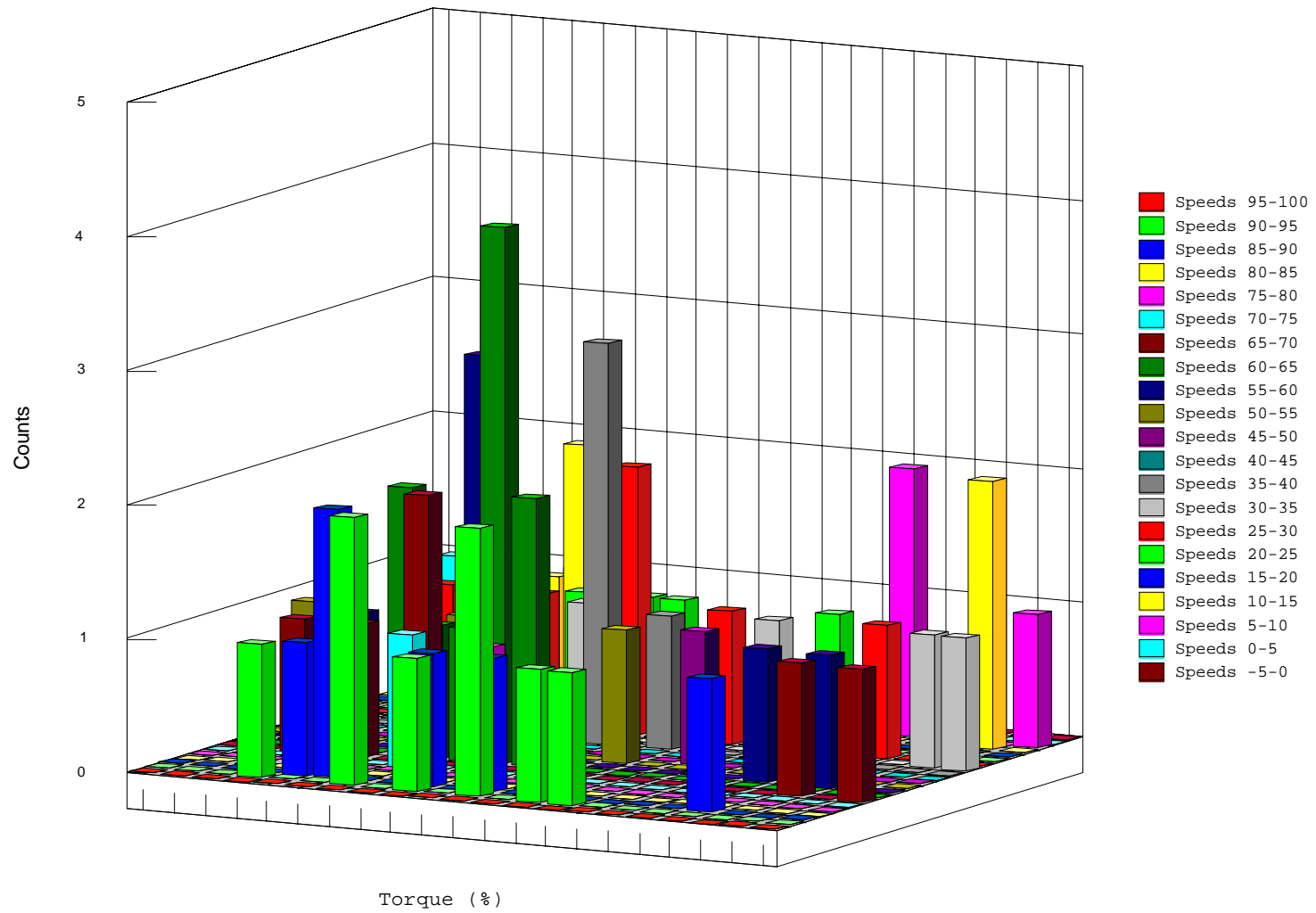
## Backhoe--Mean Speed Changes



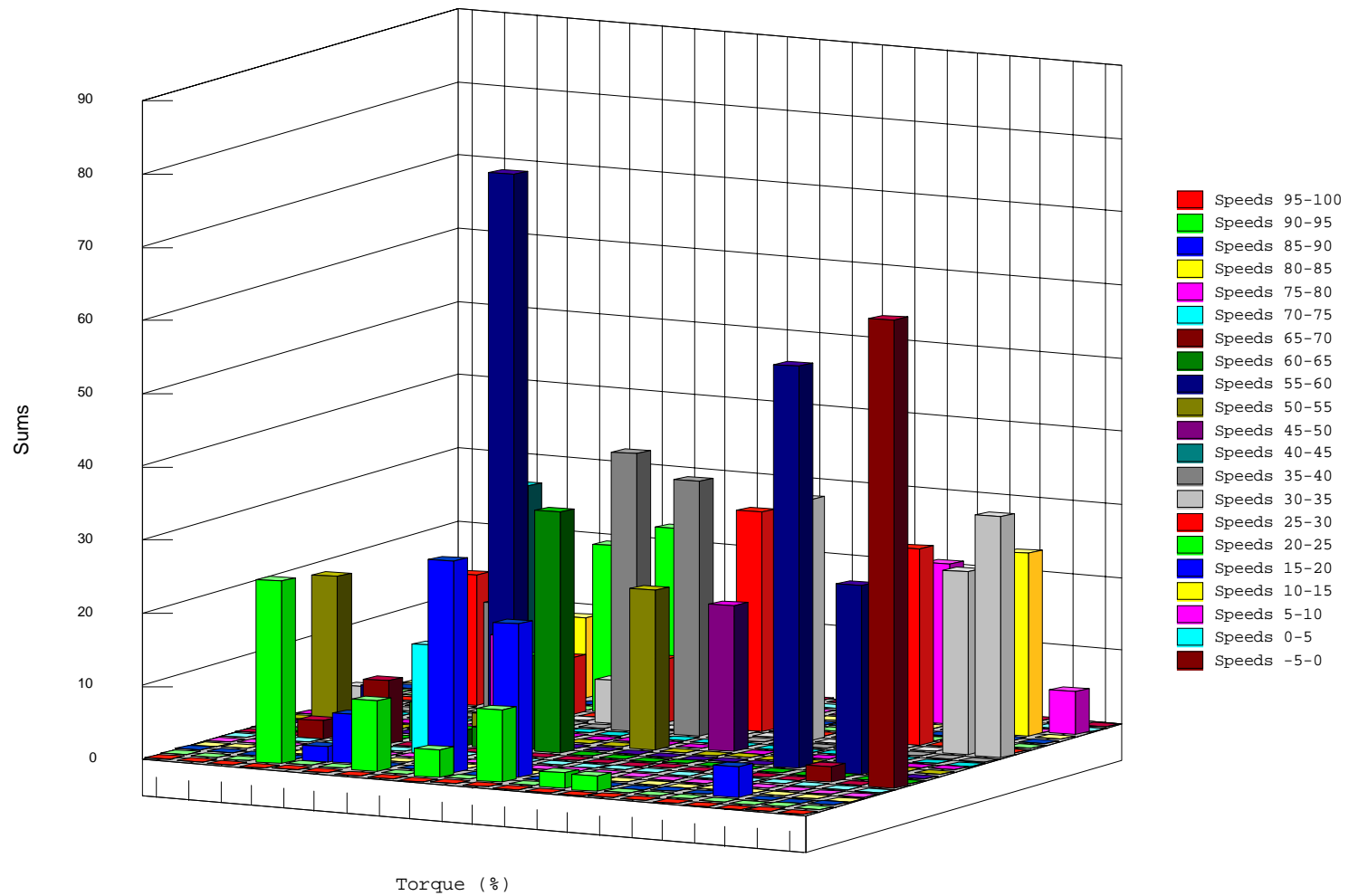
## Backhoe--Mean Torque Changes



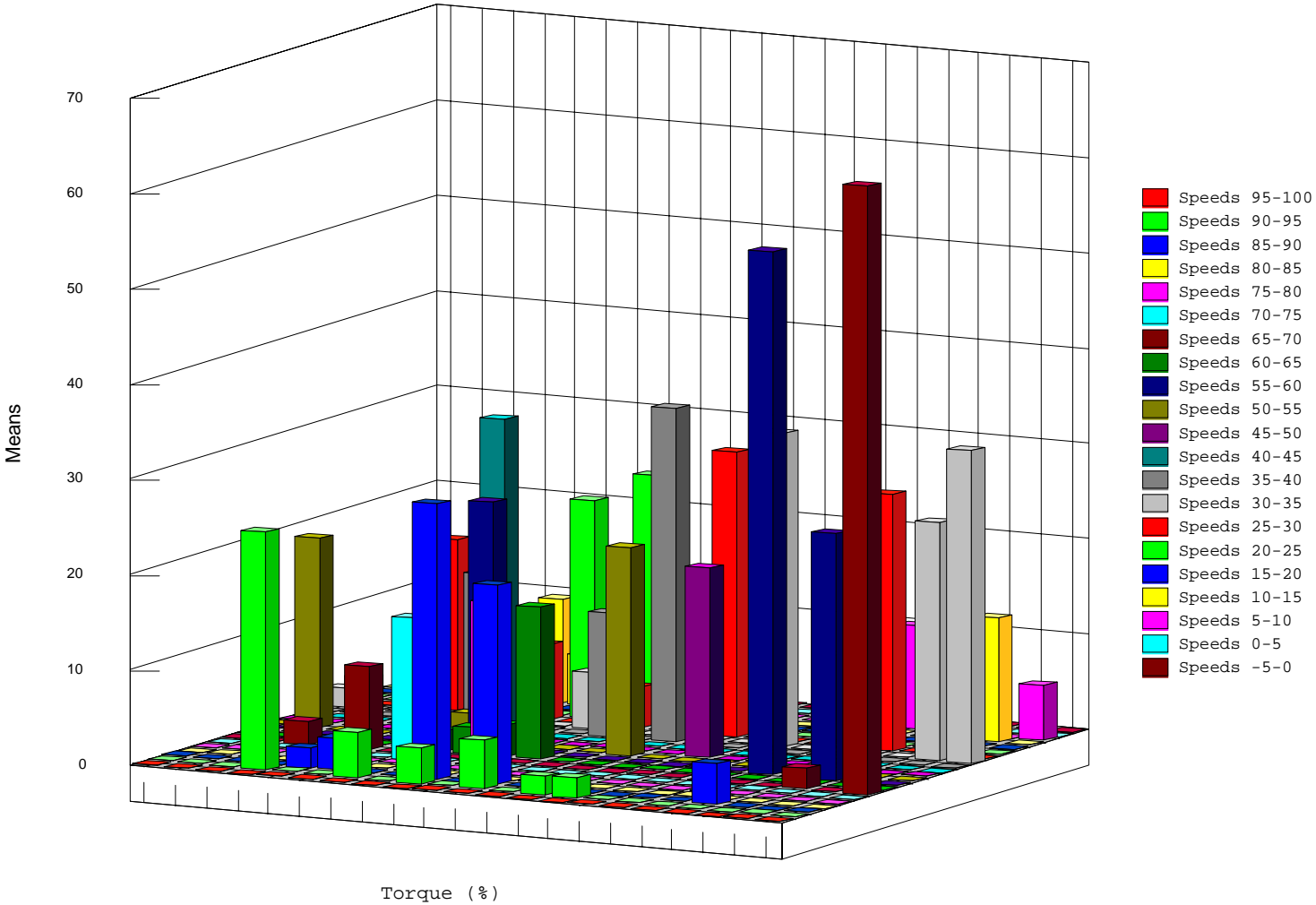
## Backhoe--Speed Acceleration Counts



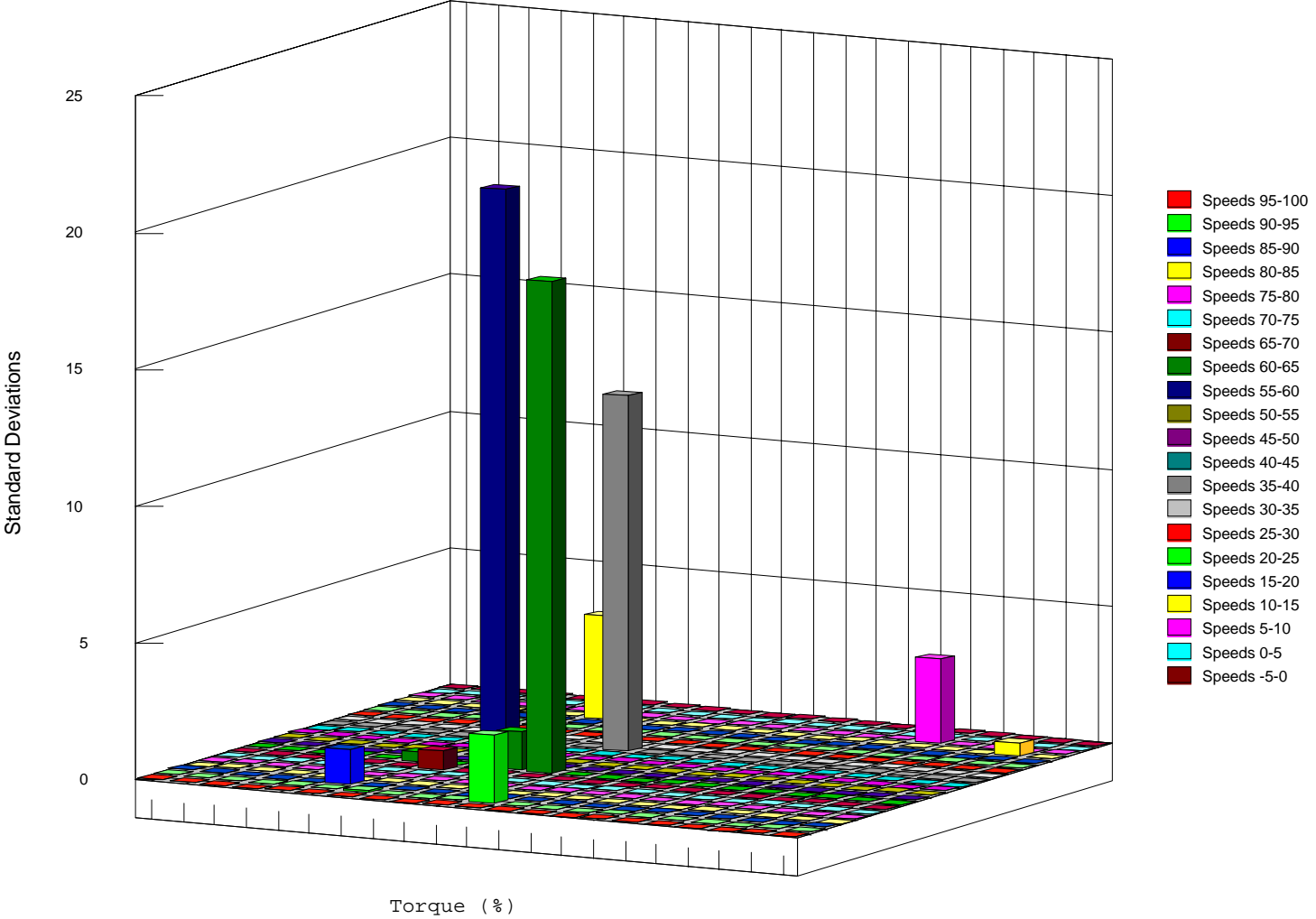
## Backhoe--Speed Acceleration Sums



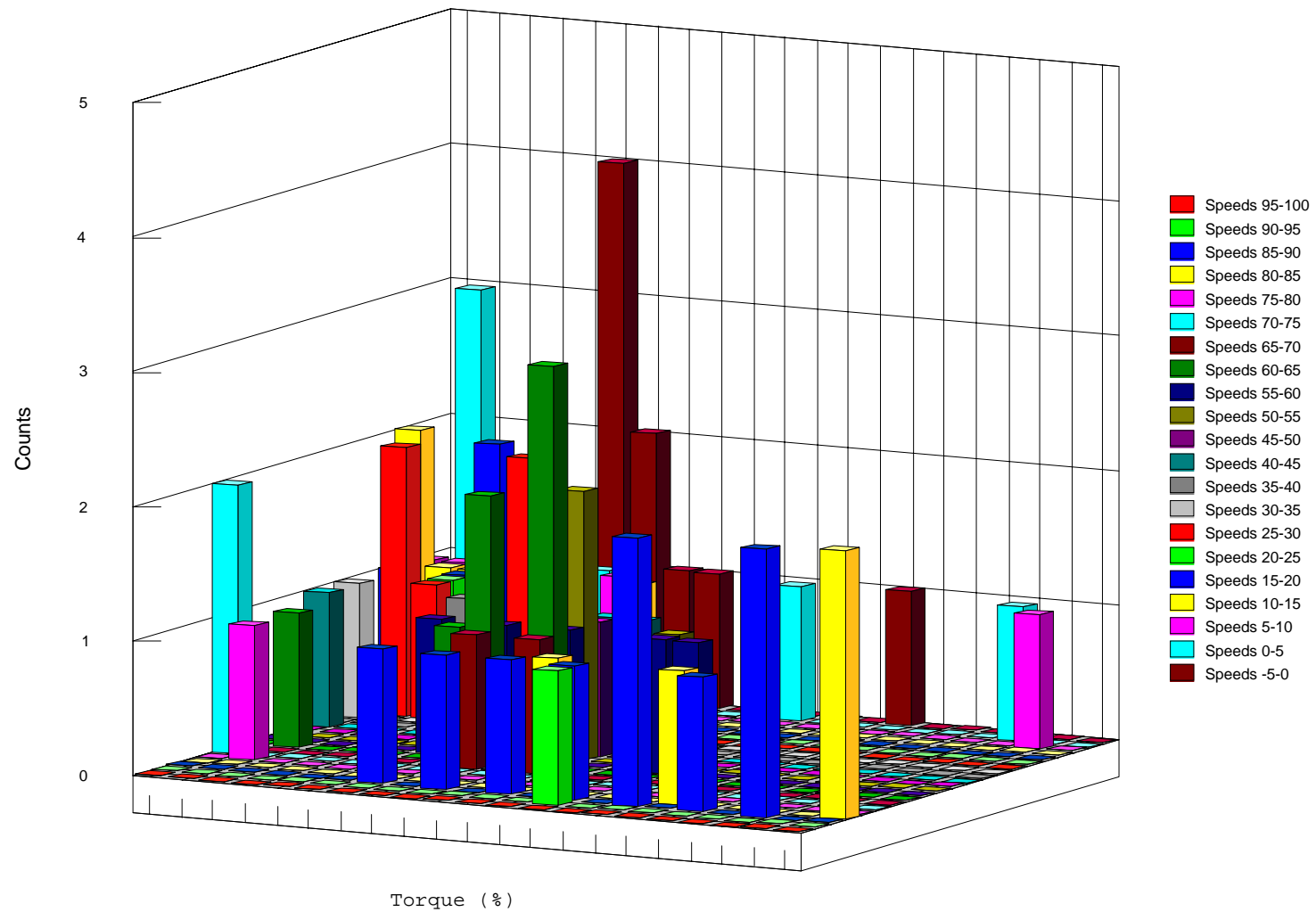
## Backhoe--Speed Acceleration Means



Backhoe--Speed Acceleration Std. Deviations	
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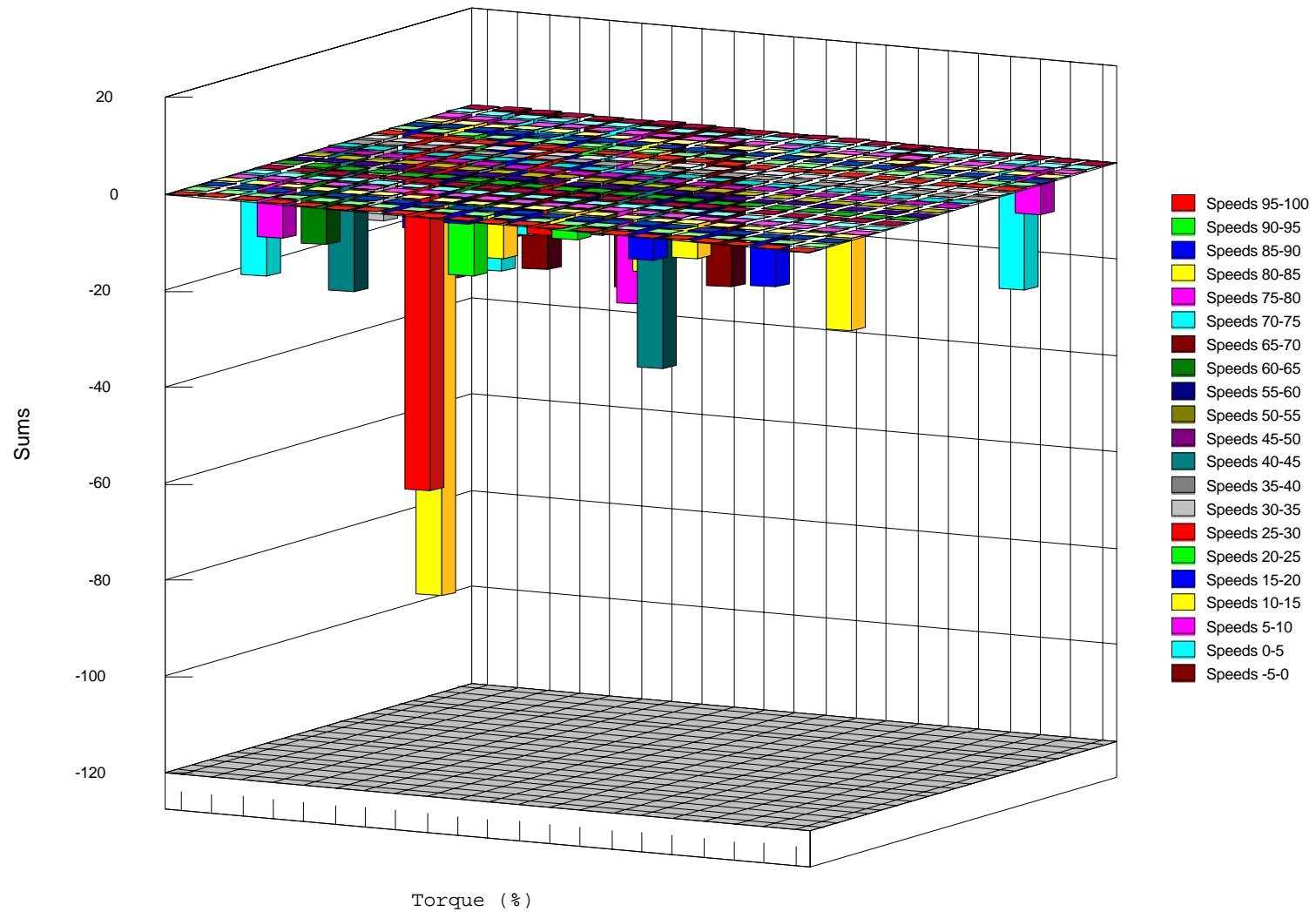


## Backhoe--Speed Deceleration Counts

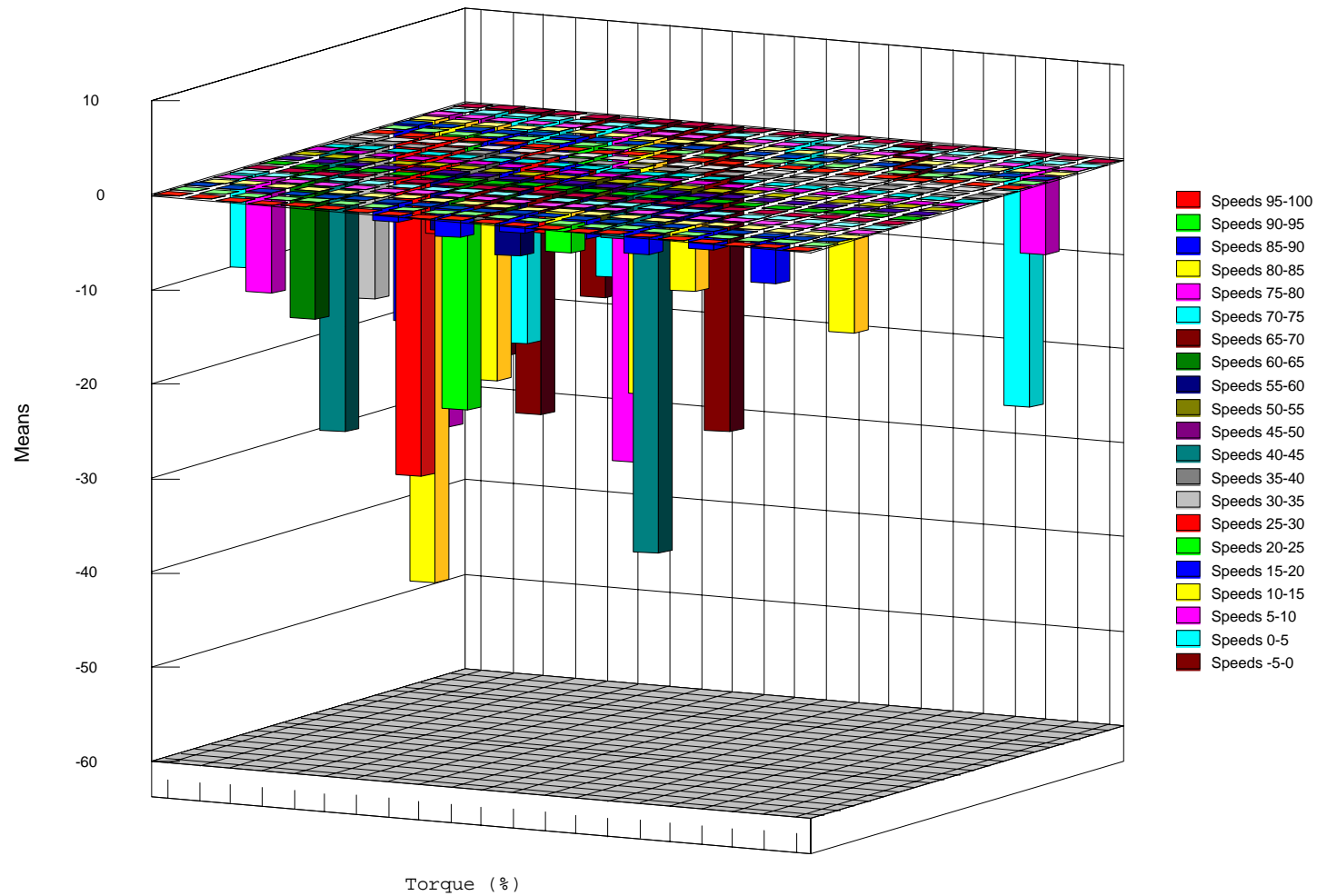




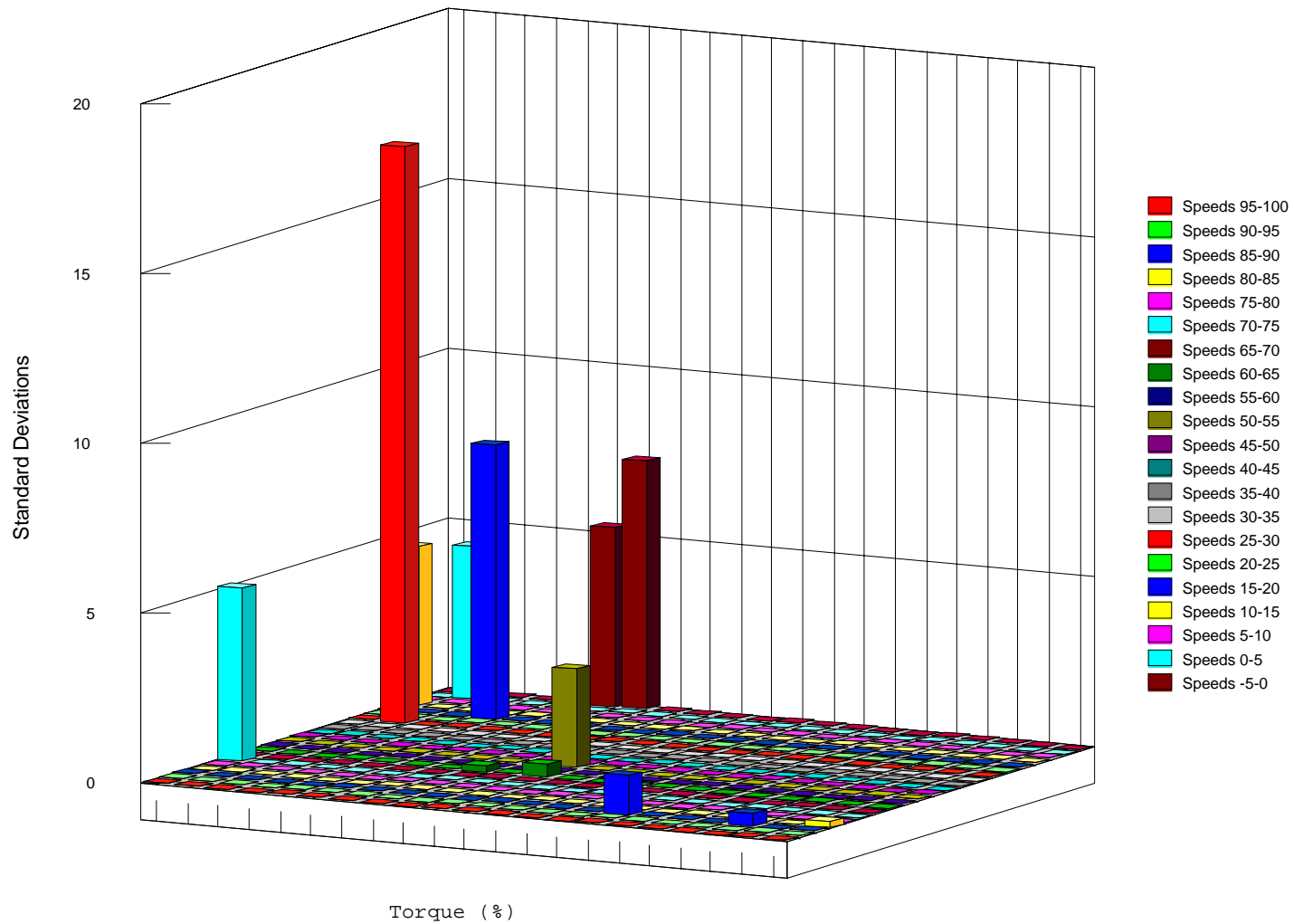
## Backhoe--Speed Deceleration Sums



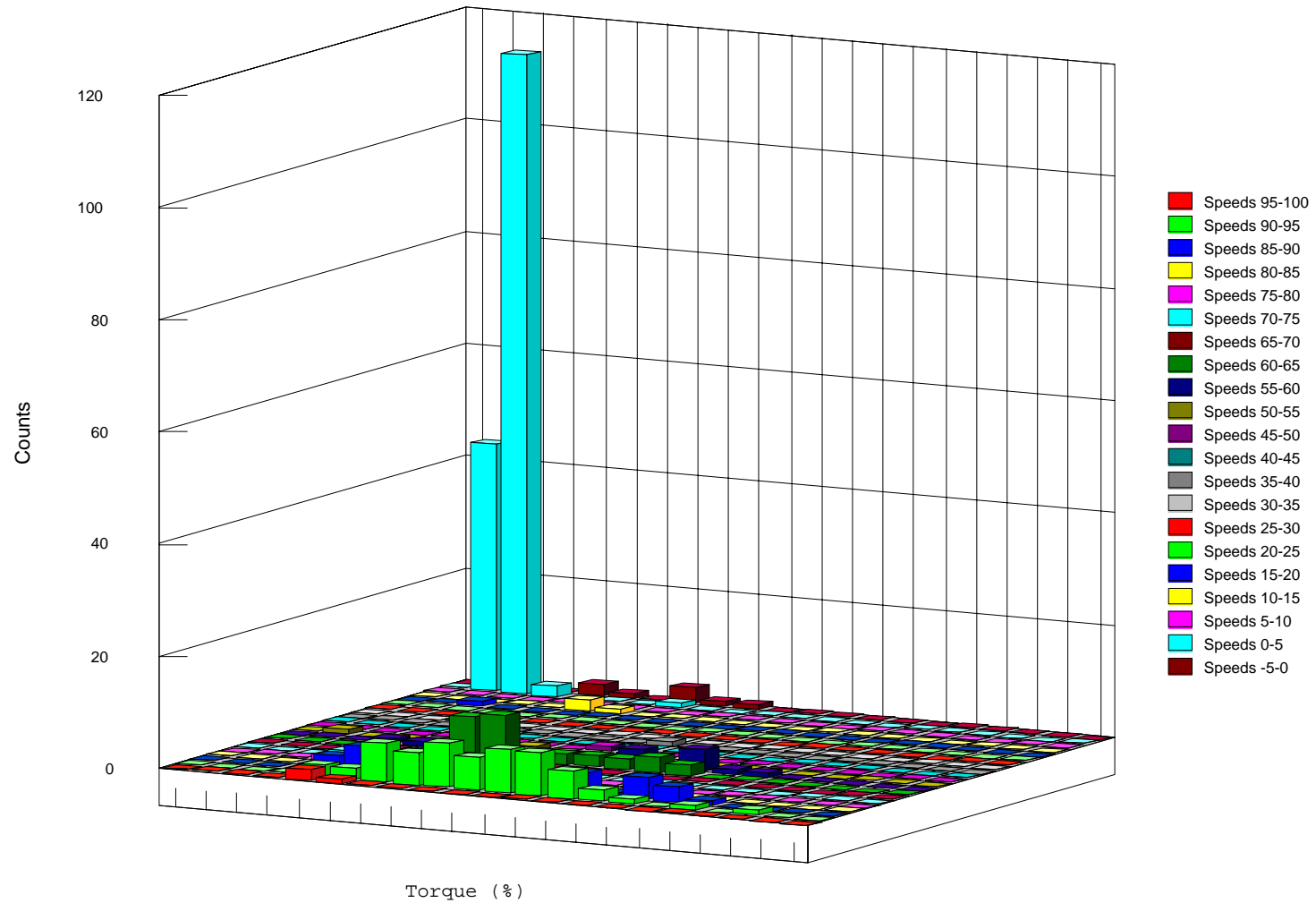
# Backhoe--Speed Deceleration Means



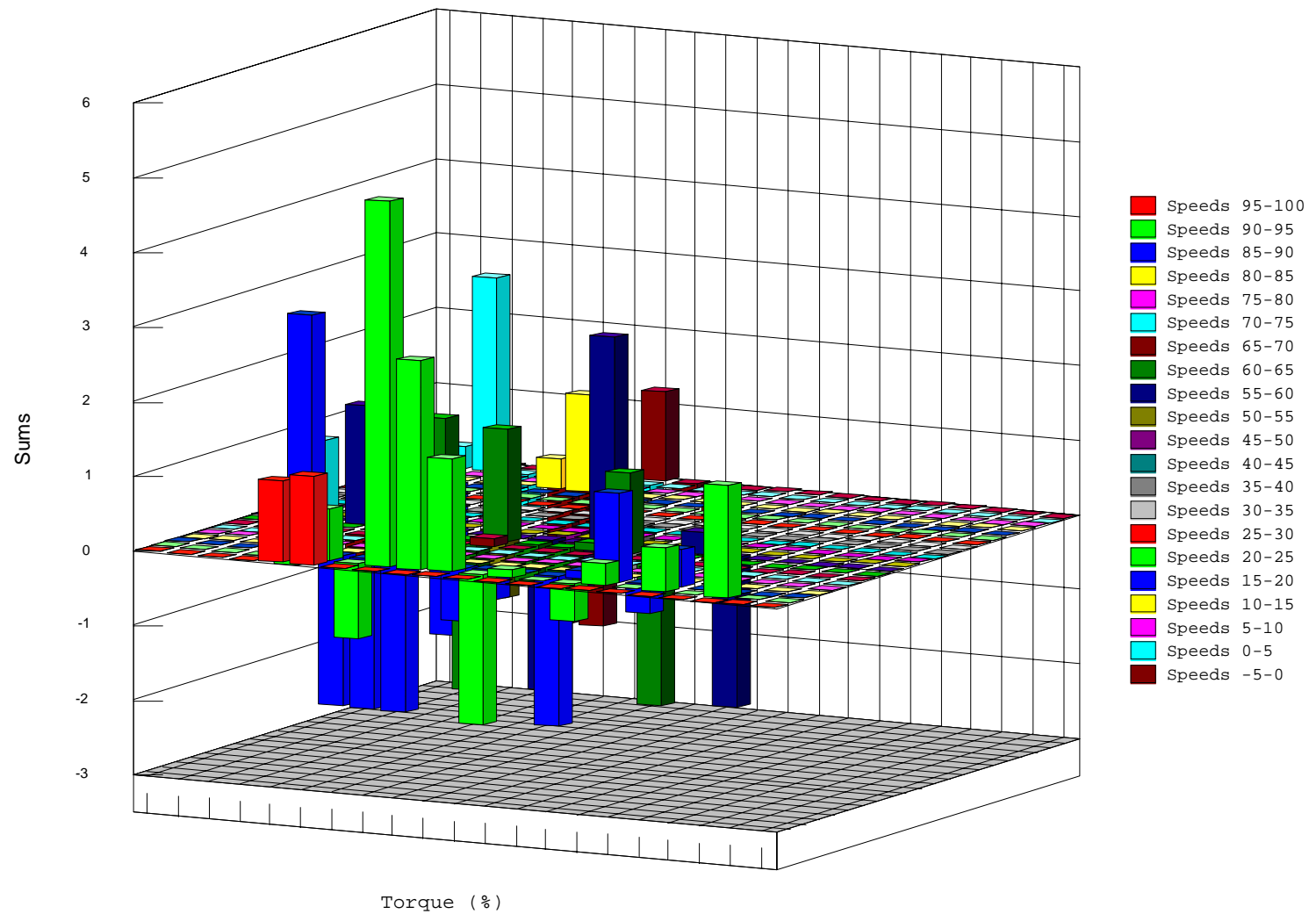
## Backhoe--Speed Deceleration Std. Deviations



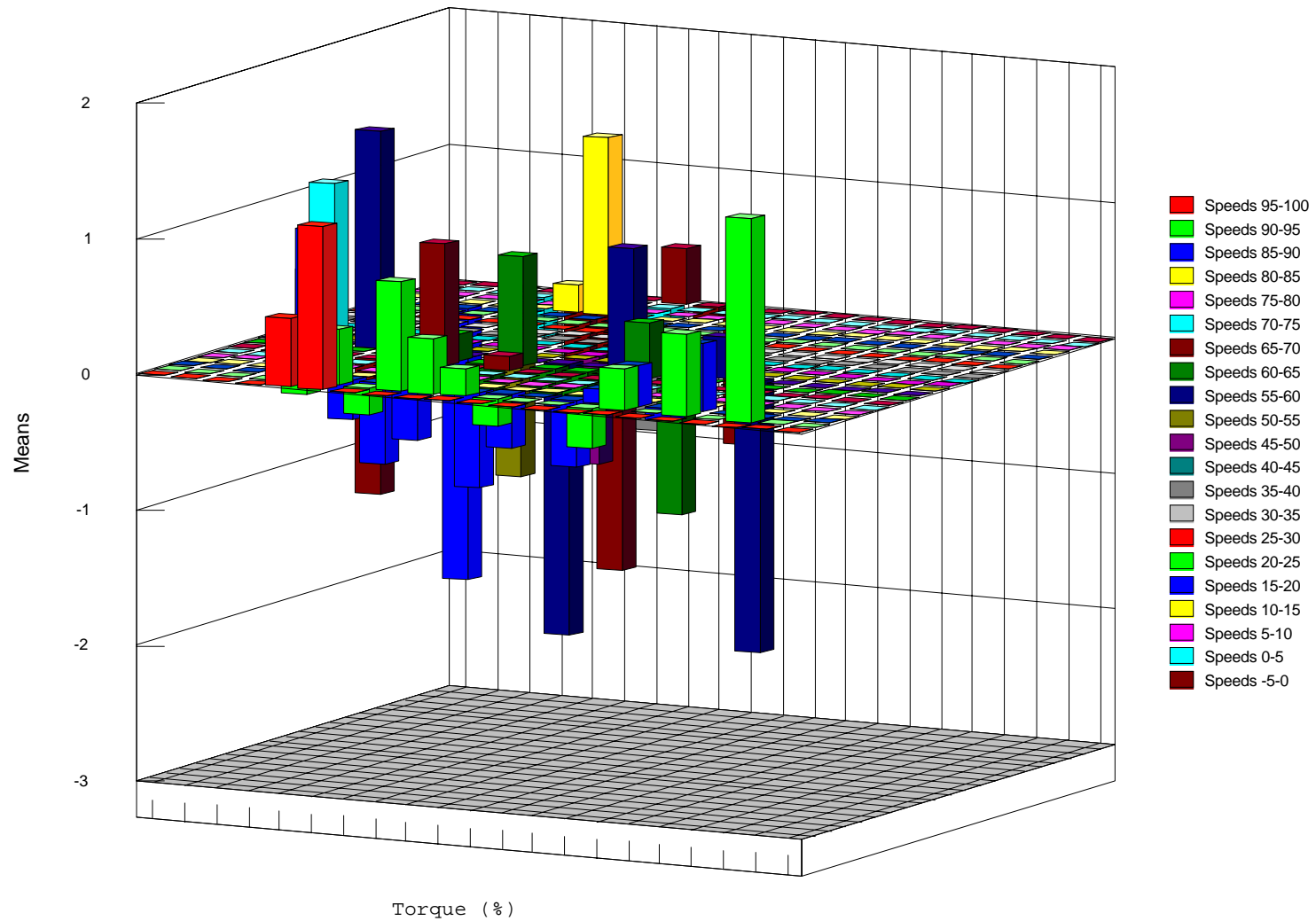
## Backhoe--Speed Steady State Counts



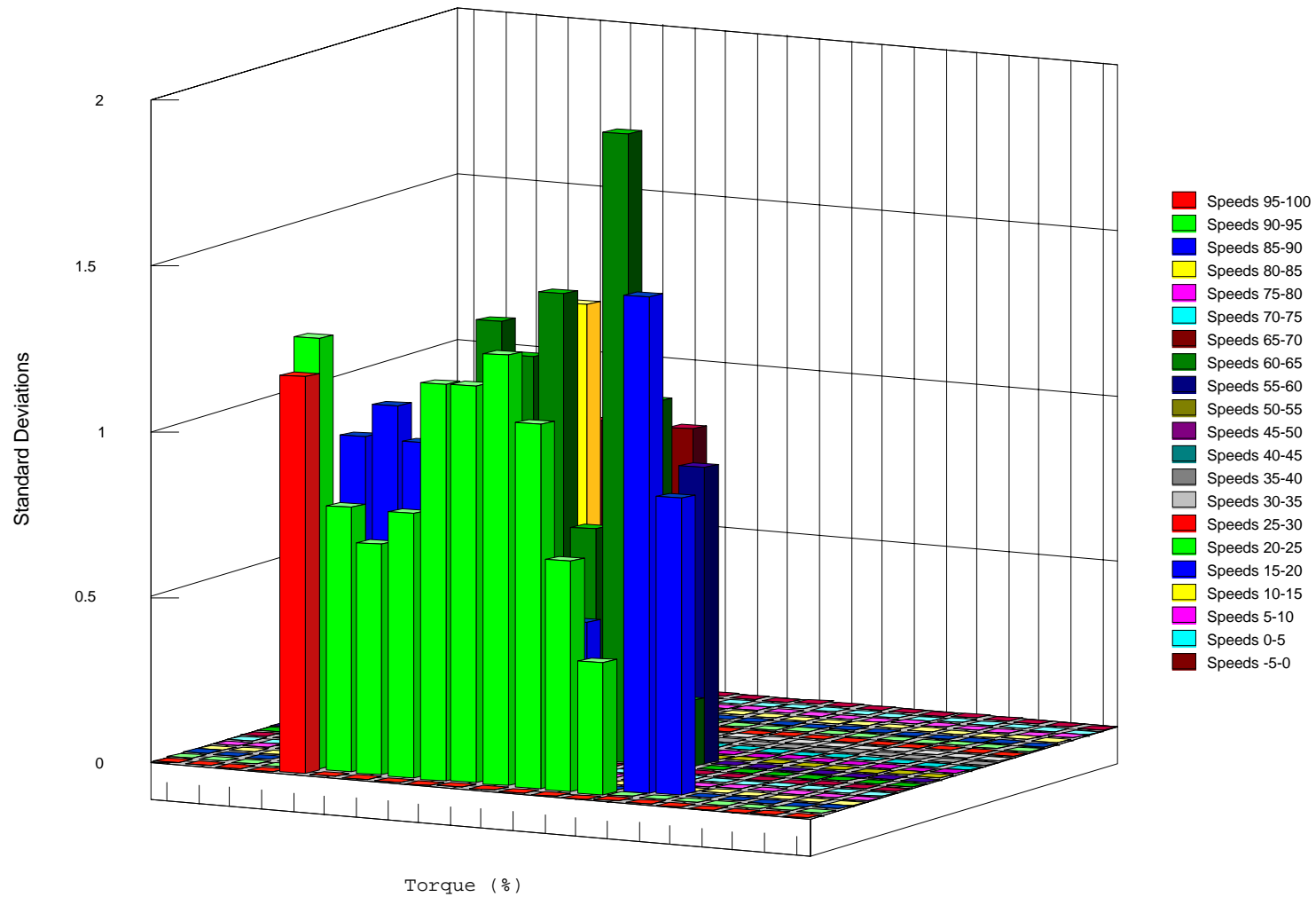
## Backhoe--Speed Steady State Sums



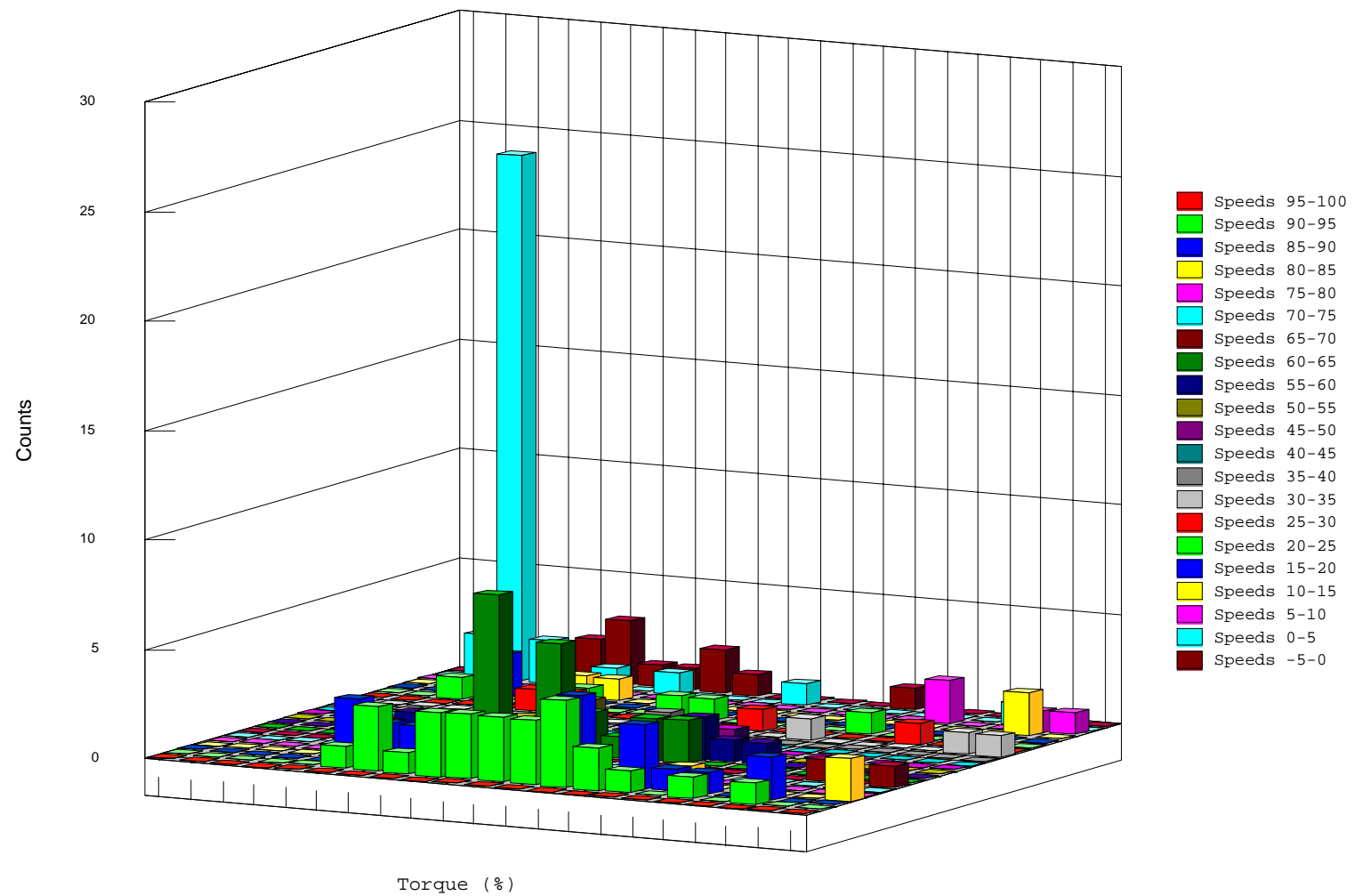
## Backhoe--Speed Steady State Means



Backhoe--Speed Steady State Std. Deviations	
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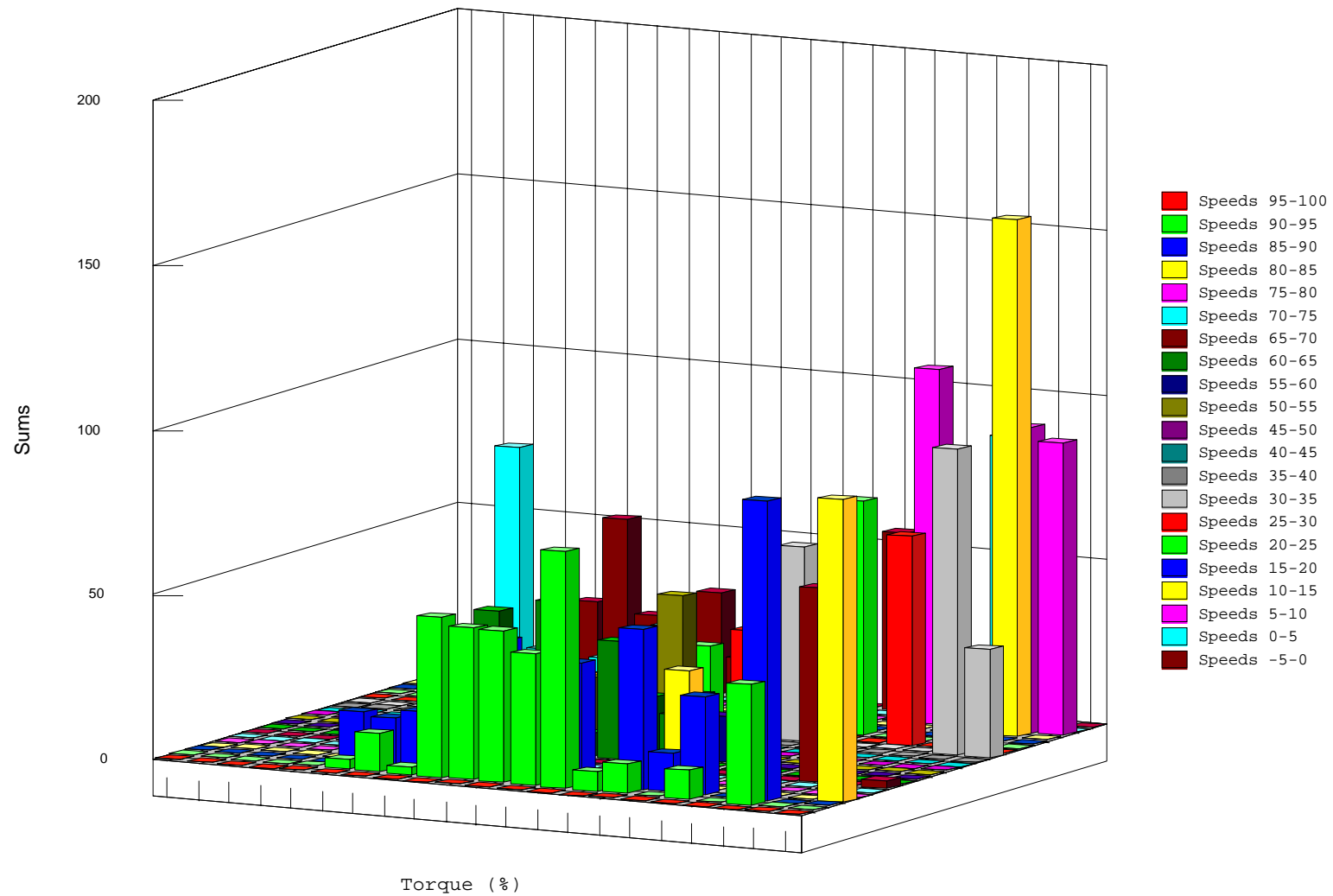


## Backhoe--Torque Acceleration Counts

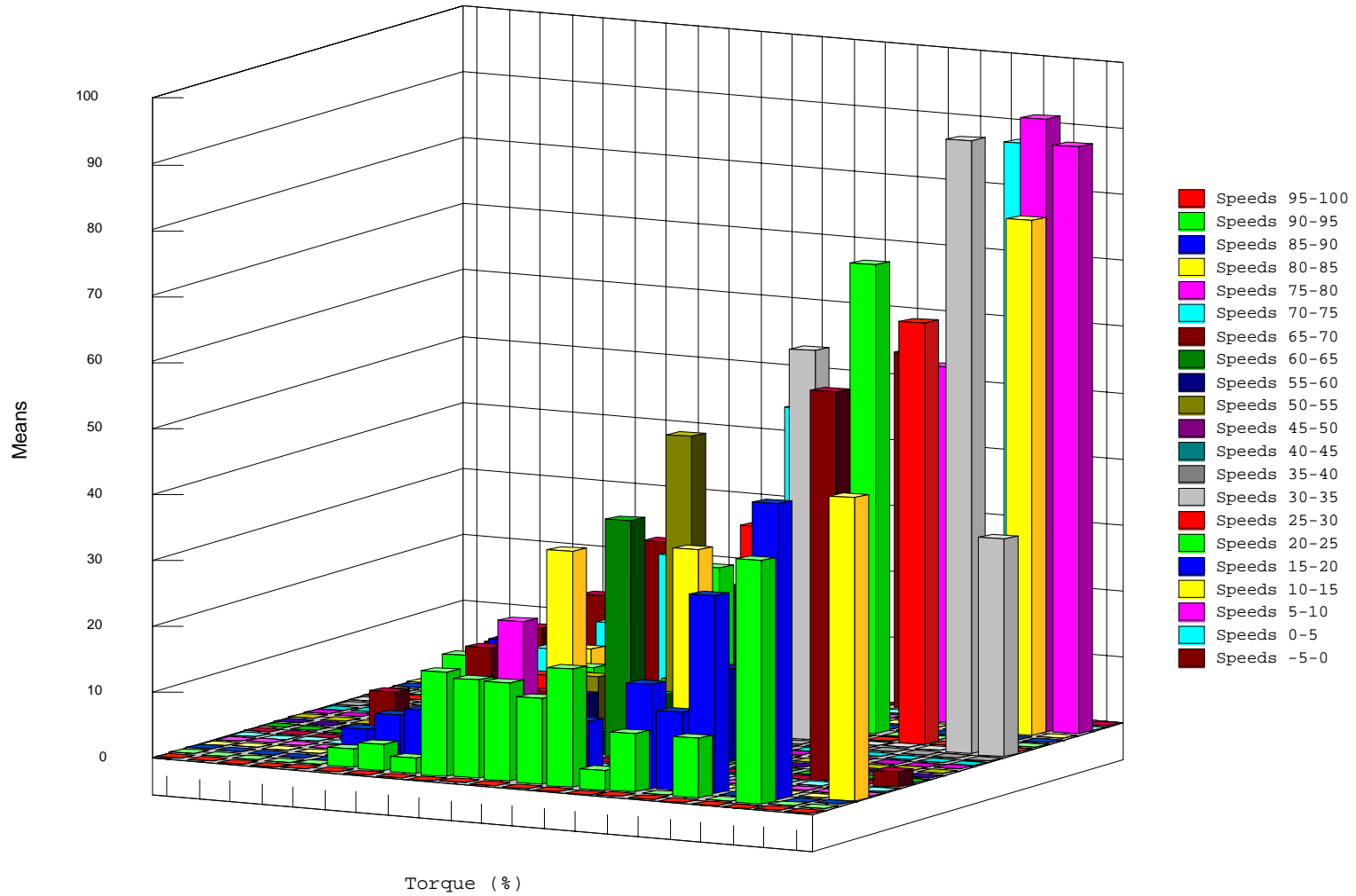




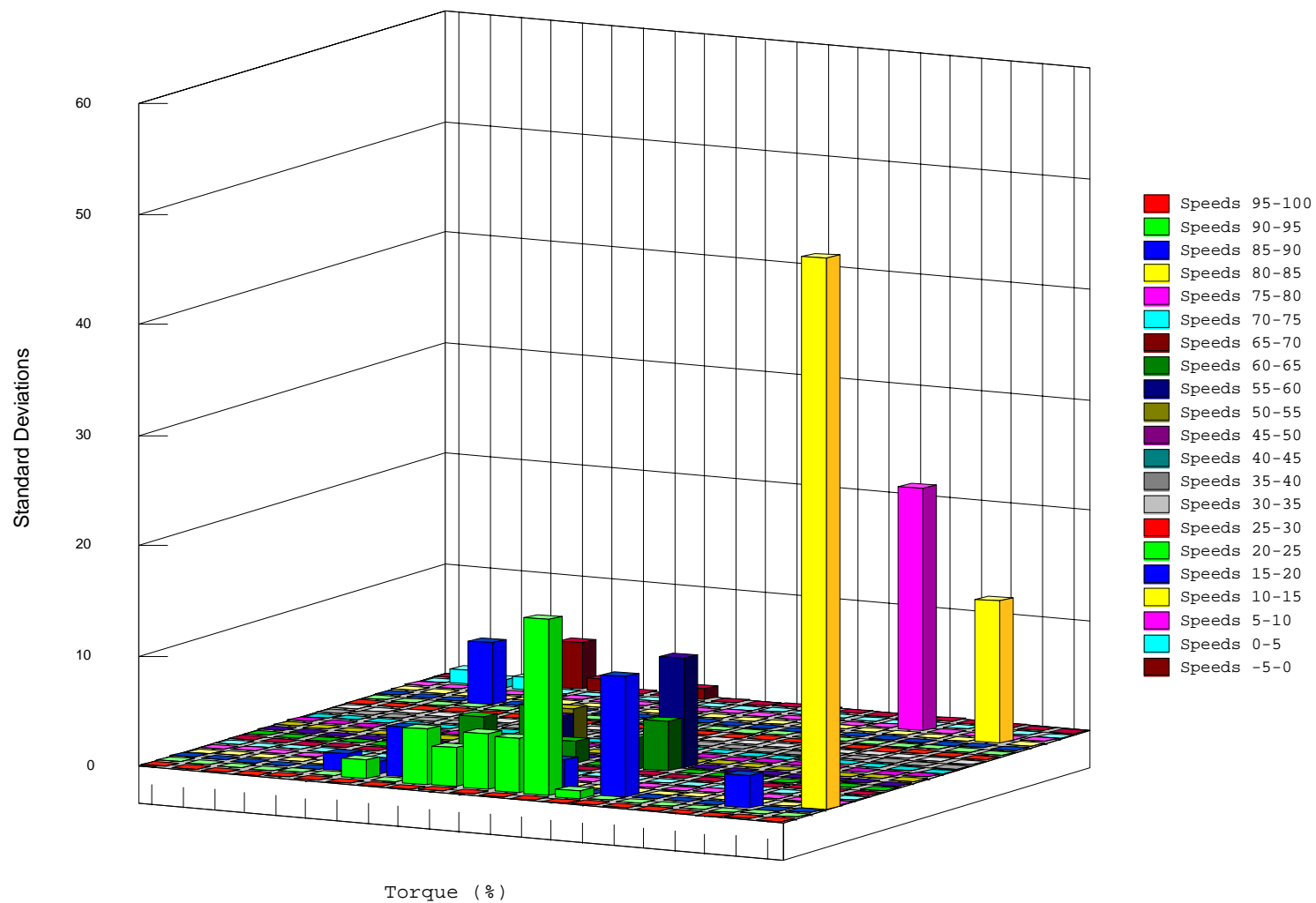
## Backhoe--Torque Acceleration Sums



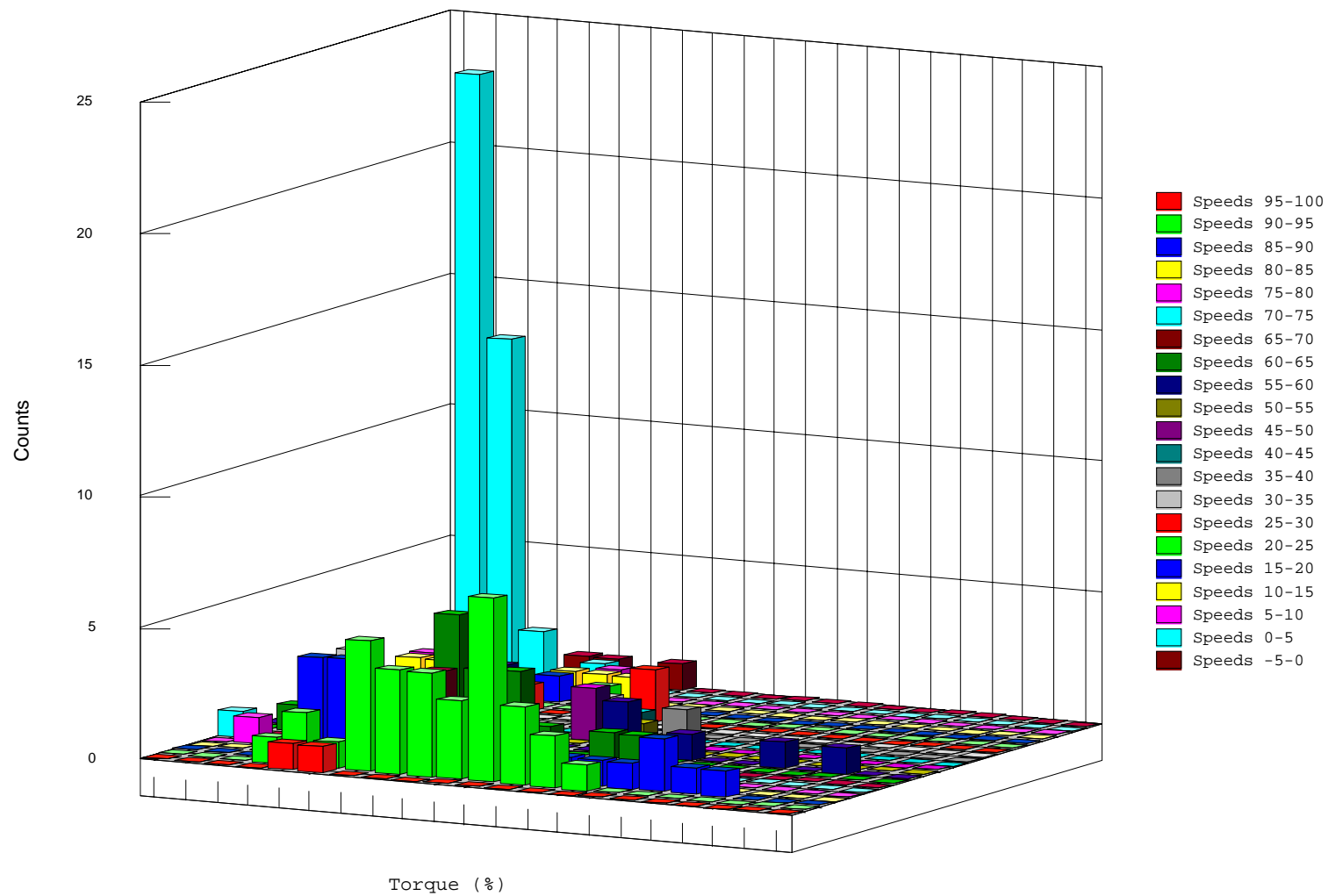
## Backhoe--Torque Acceleration Means



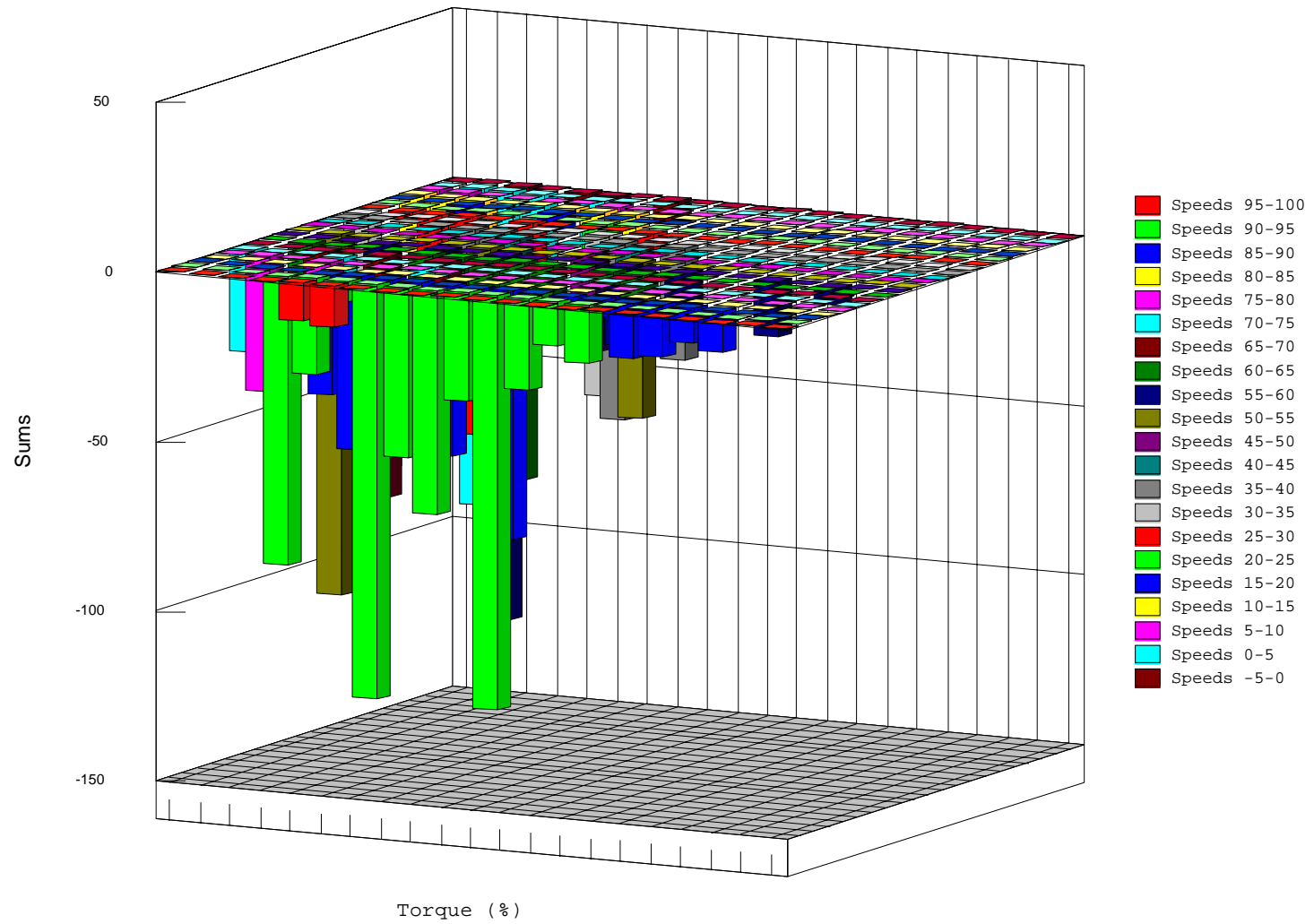
## Backhoe--Torque Acceleration Std. Deviations



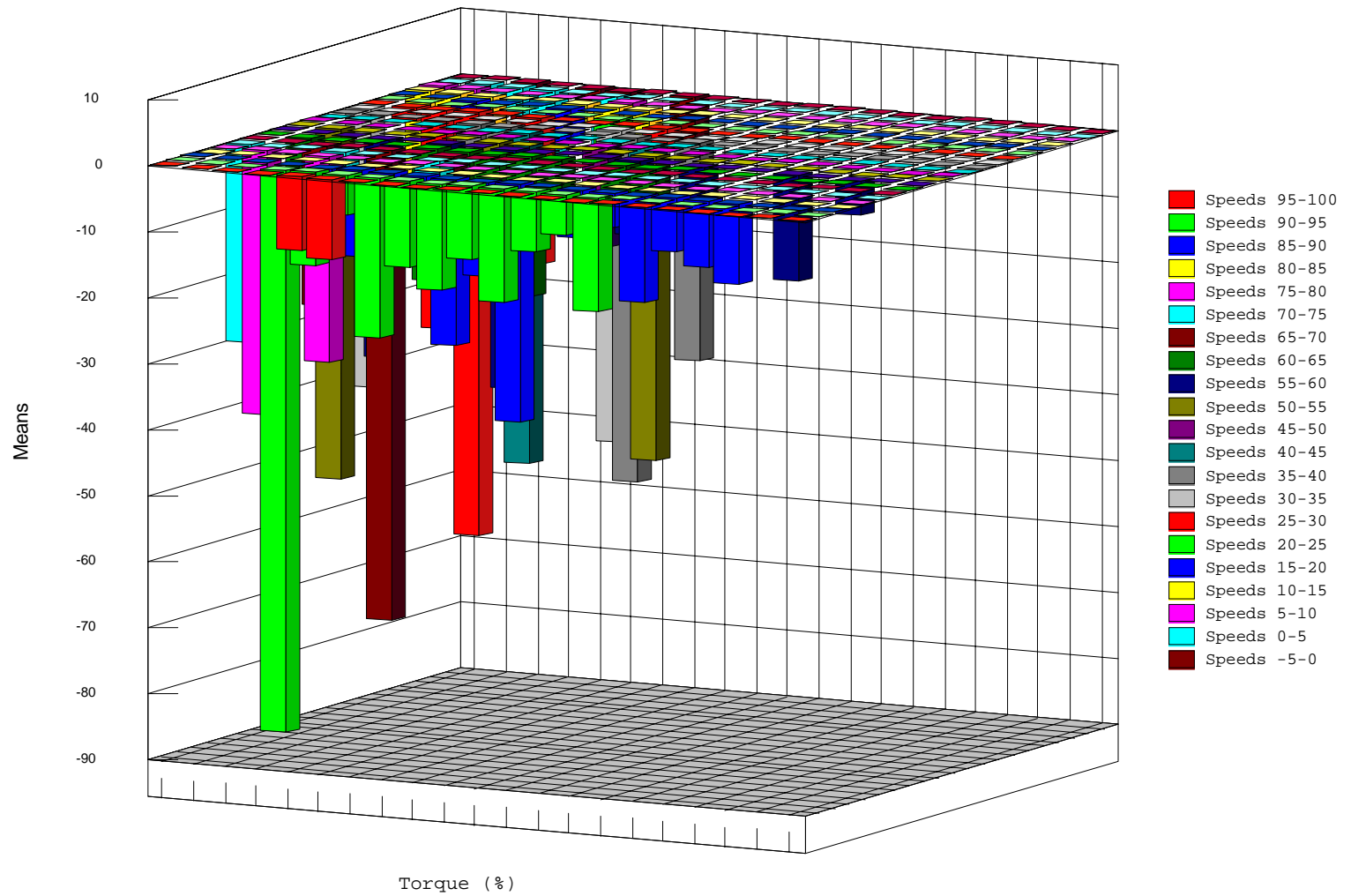
## Backhoe--Torque Deceleration Counts



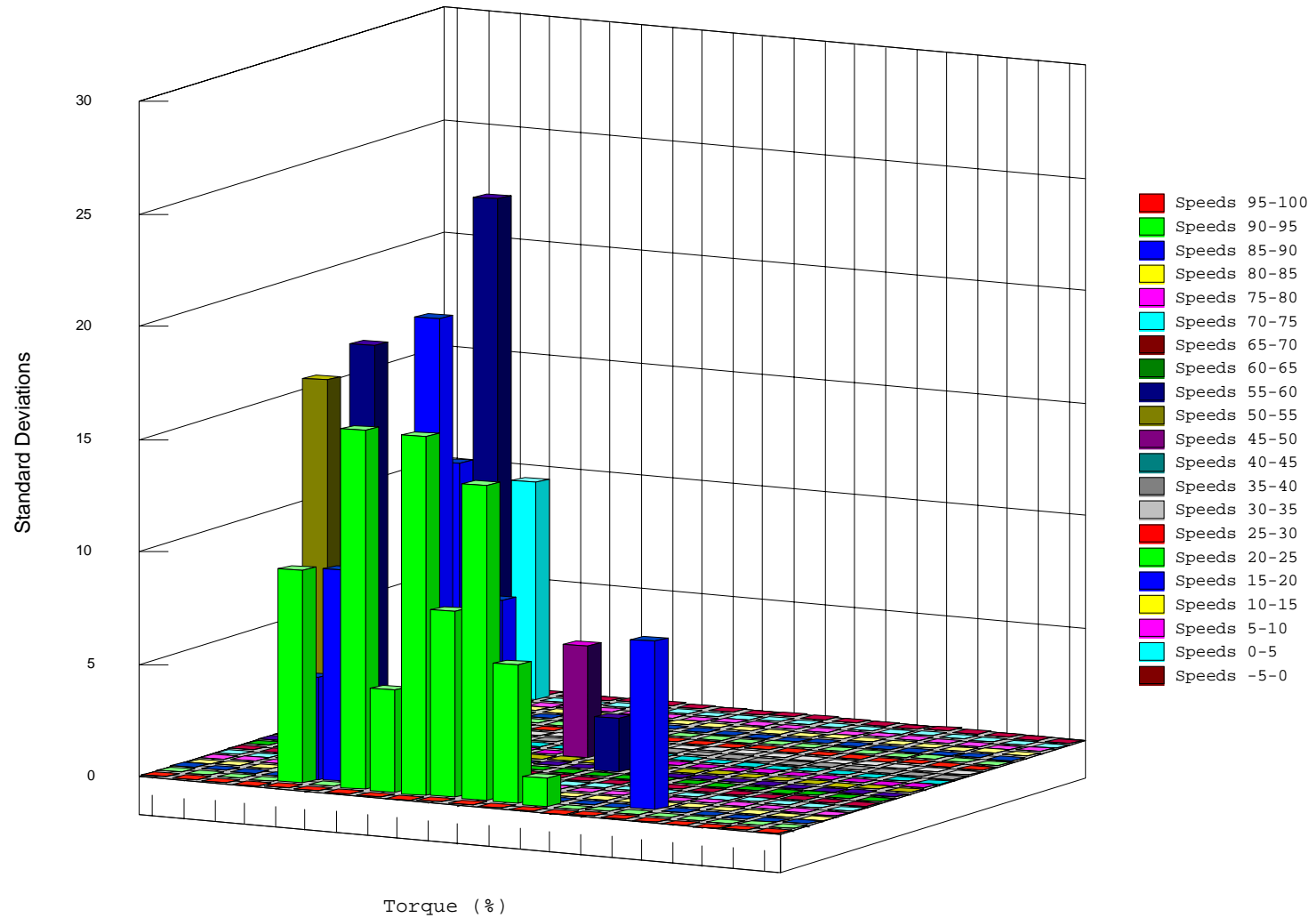
## Backhoe--Torque Deceleration Sums



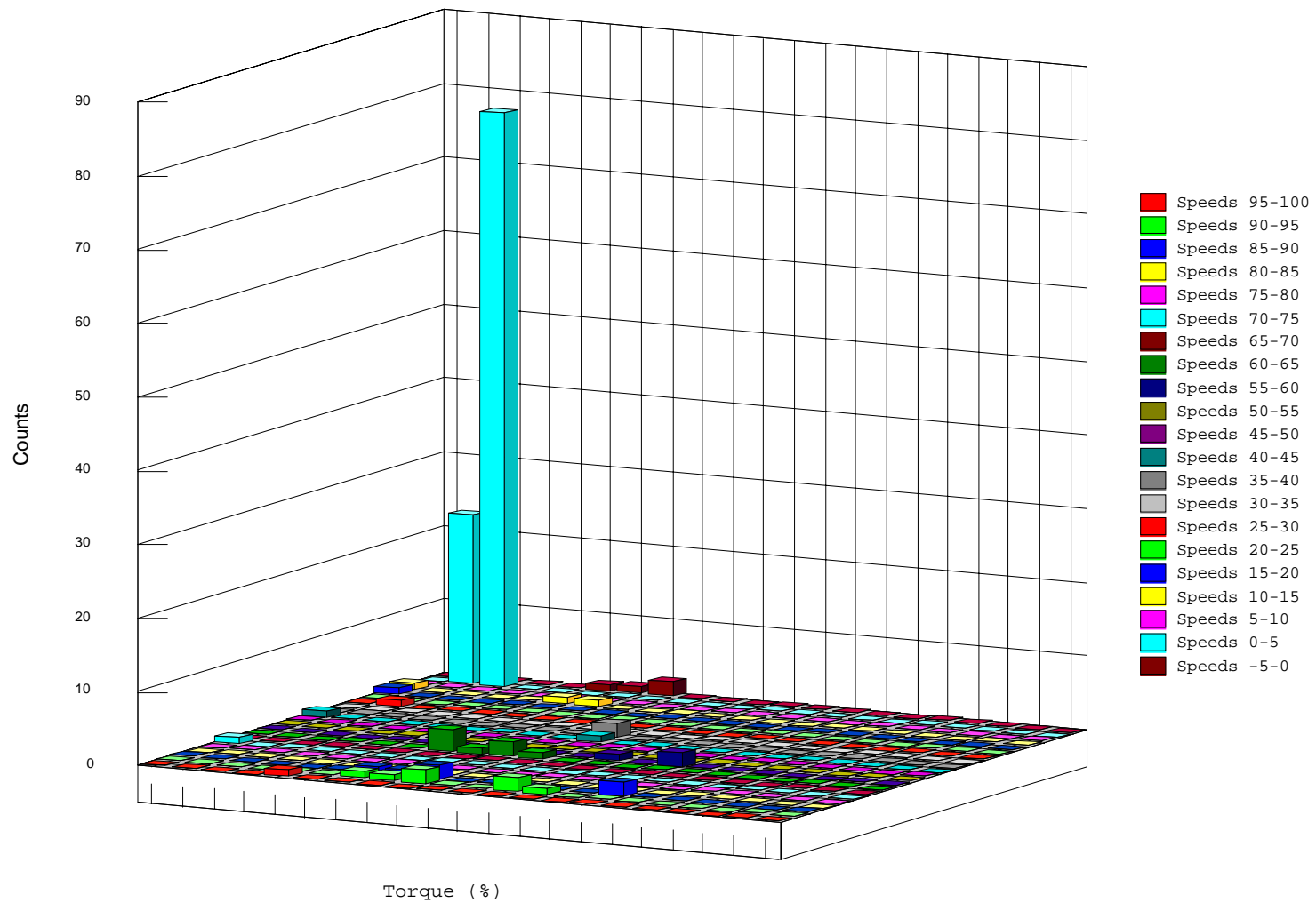
# Backhoe--Torque Deceleration Means



Backhoe--Torque Deceleration Std. Deviations	
1	0.0000
2	0.0000
3	0.0000
4	0.0000
5	0.0000
6	0.0000
7	0.0000
8	0.0000
9	0.0000
10	0.0000
11	0.0000
12	0.0000
13	0.0000
14	0.0000
15	0.0000
16	0.0000
17	0.0000
18	0.0000
19	0.0000
20	0.0000
21	0.0000
22	0.0000
23	0.0000
24	0.0000
25	0.0000
26	0.0000
27	0.0000
28	0.0000
29	0.0000
30	0.0000
31	0.0000
32	0.0000
33	0.0000
34	0.0000
35	0.0000
36	0.0000
37	0.0000
38	0.0000
39	0.0000
40	0.0000
41	0.0000
42	0.0000
43	0.0000
44	0.0000
45	0.0000
46	0.0000
47	0.0000
48	0.0000
49	0.0000
50	0.0000
51	0.0000
52	0.0000
53	0.0000
54	0.0000
55	0.0000
56	0.0000
57	0.0000
58	0.0000
59	0.0000
60	0.0000
61	0.0000
62	0.0000
63	0.0000
64	0.0000
65	0.0000
66	0.0000
67	0.0000
68	0.0000
69	0.0000
70	0.0000
71	0.0000
72	0.0000
73	0.0000
74	0.0000
75	0.0000
76	0.0000
77	0.0000
78	0.0000
79	0.0000
80	0.0000
81	0.0000
82	0.0000
83	0.0000
84	0.0000
85	0.0000
86	0.0000
87	0.0000
88	0.0000
89	0.0000
90	0.0000
91	0.0000
92	0.0000
93	0.0000
94	0.0000
95	0.0000
96	0.0000
97	0.0000
98	0.0000
99	0.0000
100	0.0000

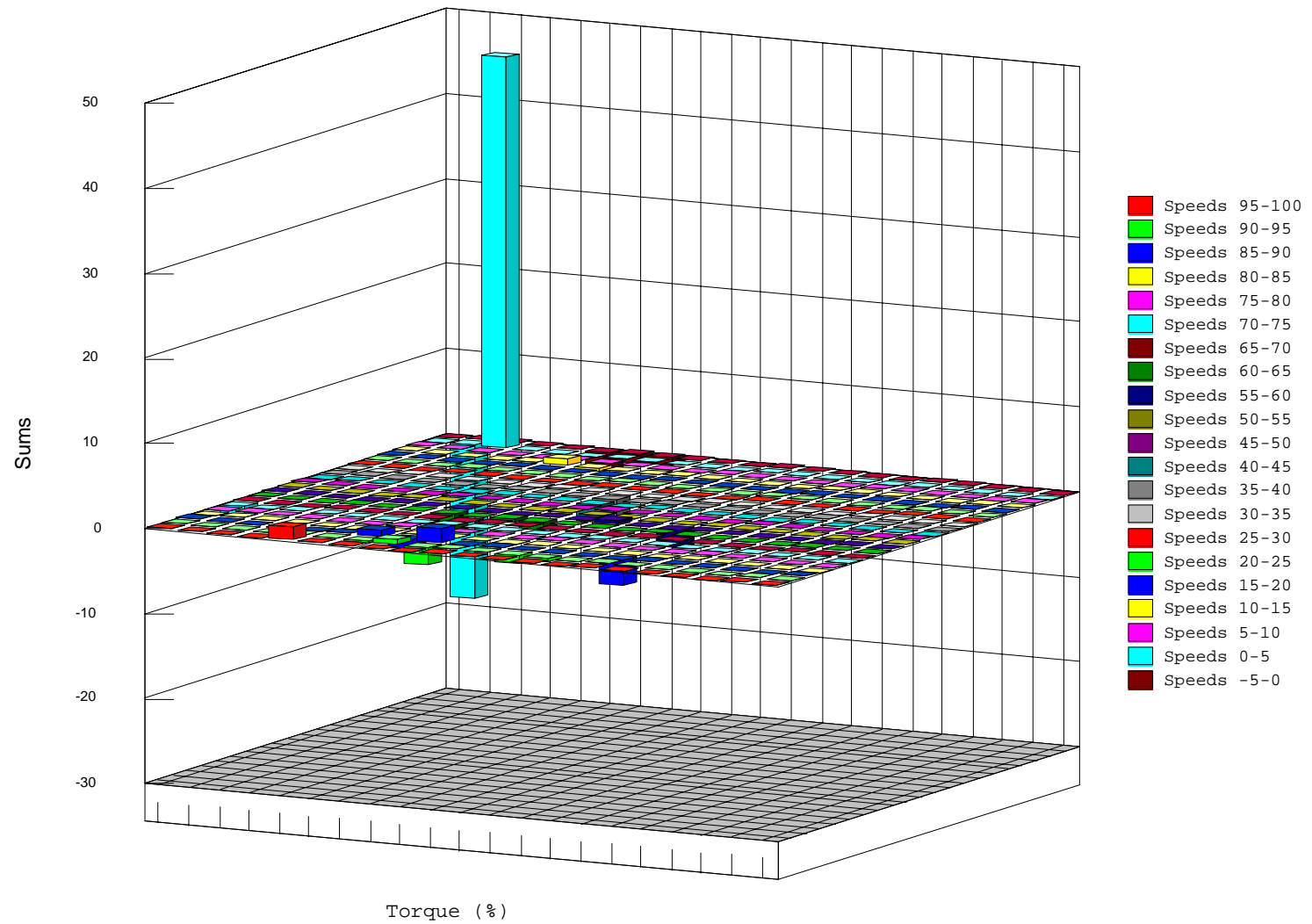


## Backhoe--Torque Steady State Counts

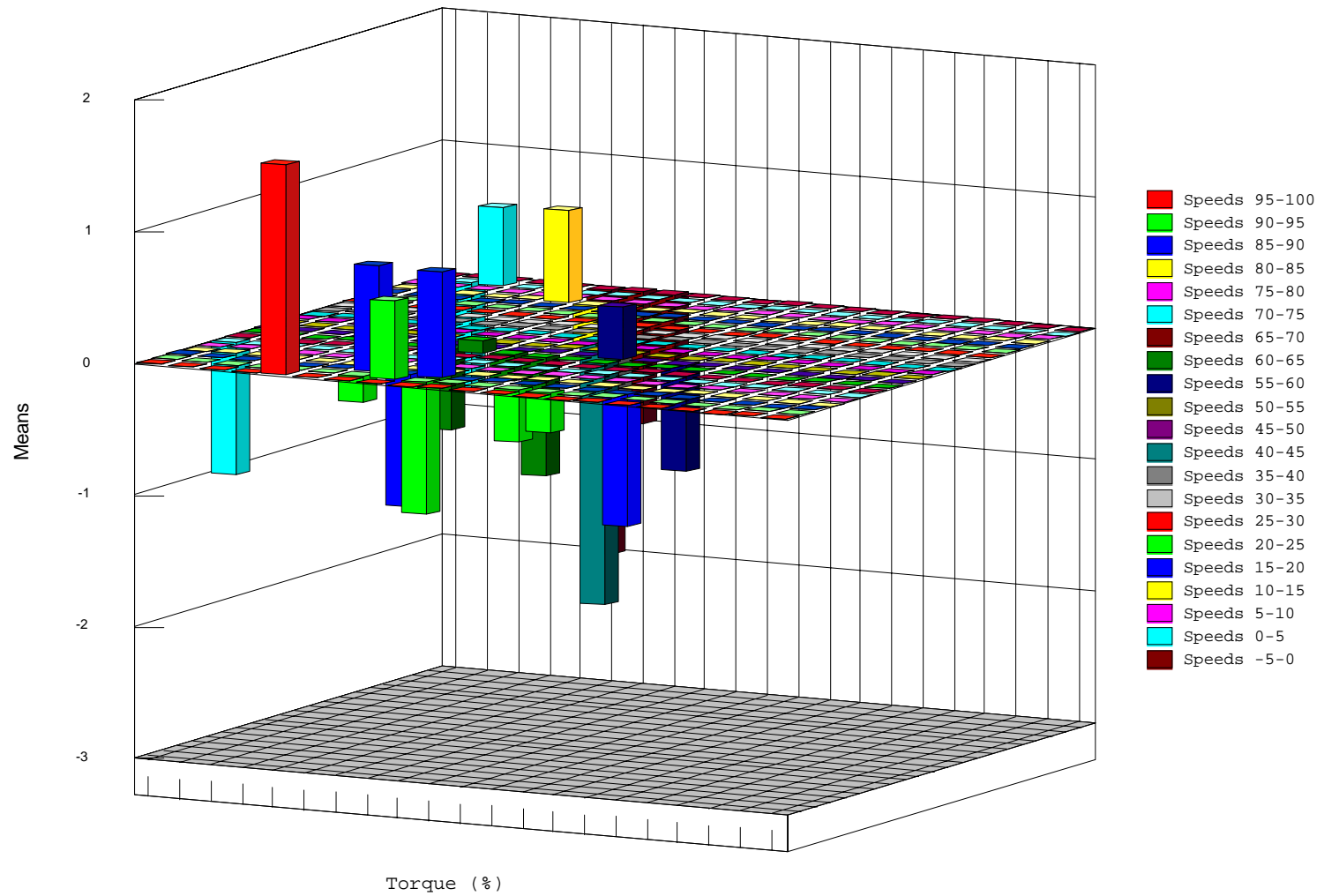




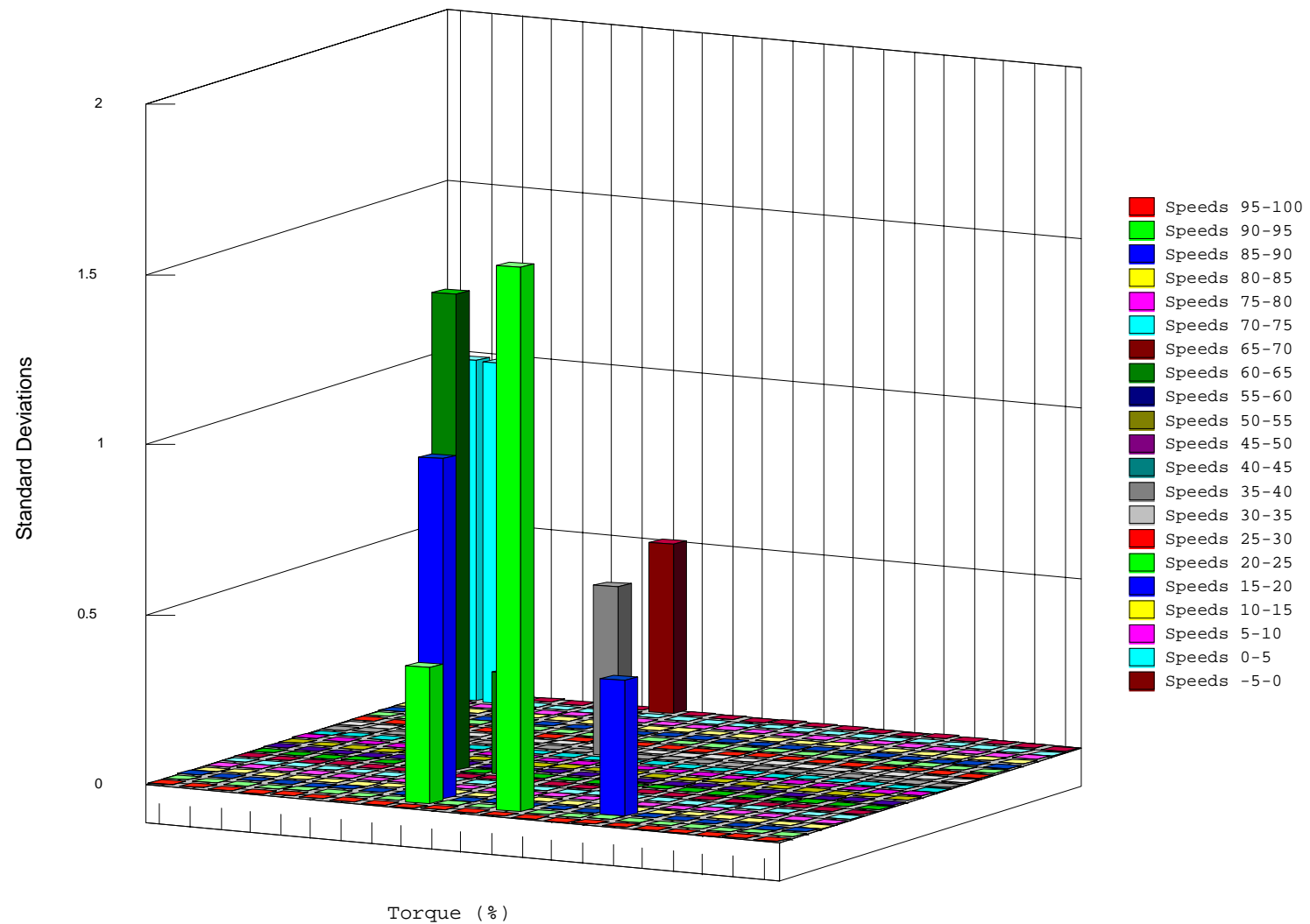
## Backhoe--Torque Steady State Sums



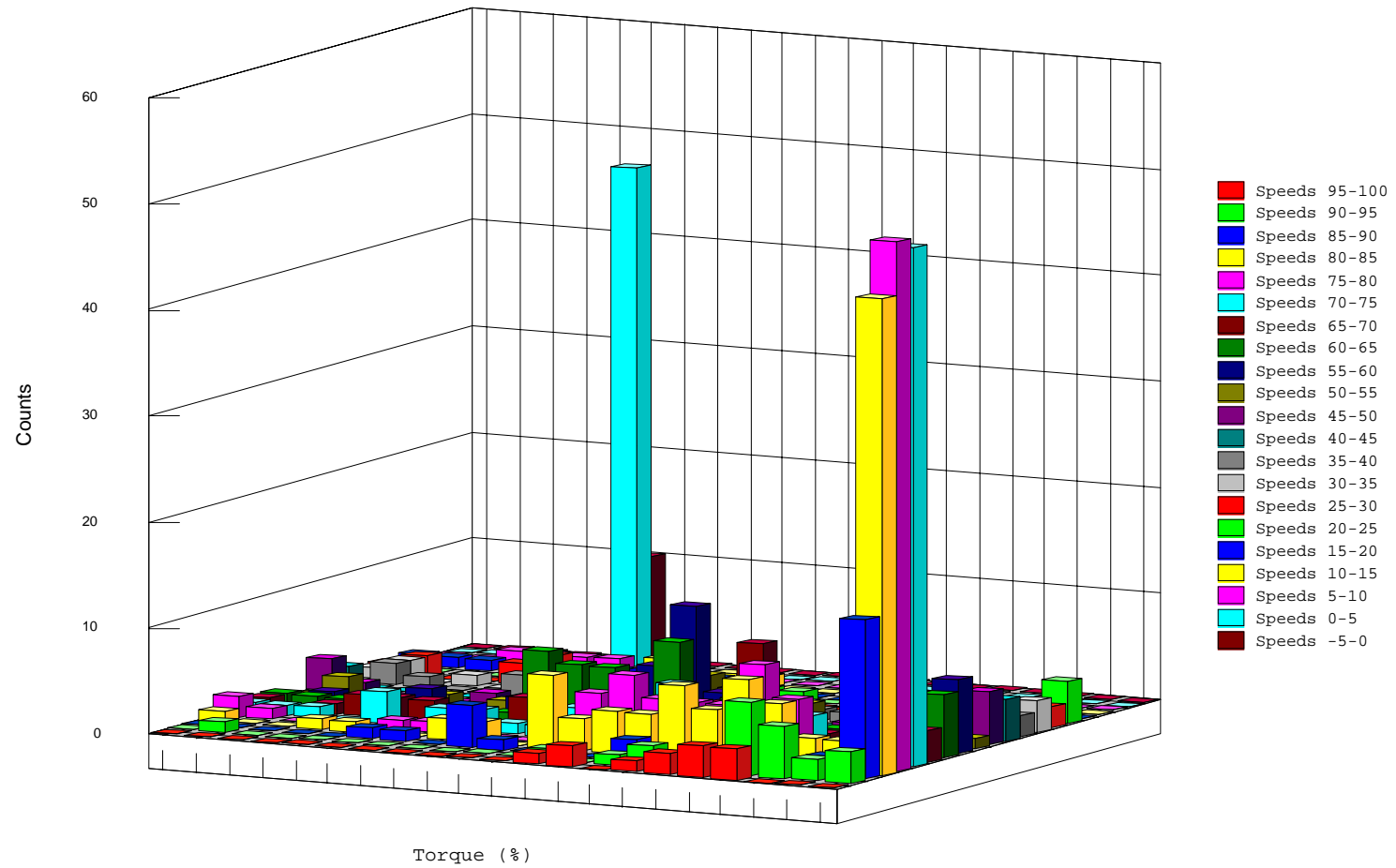
## Backhoe--Torque Steady State Means



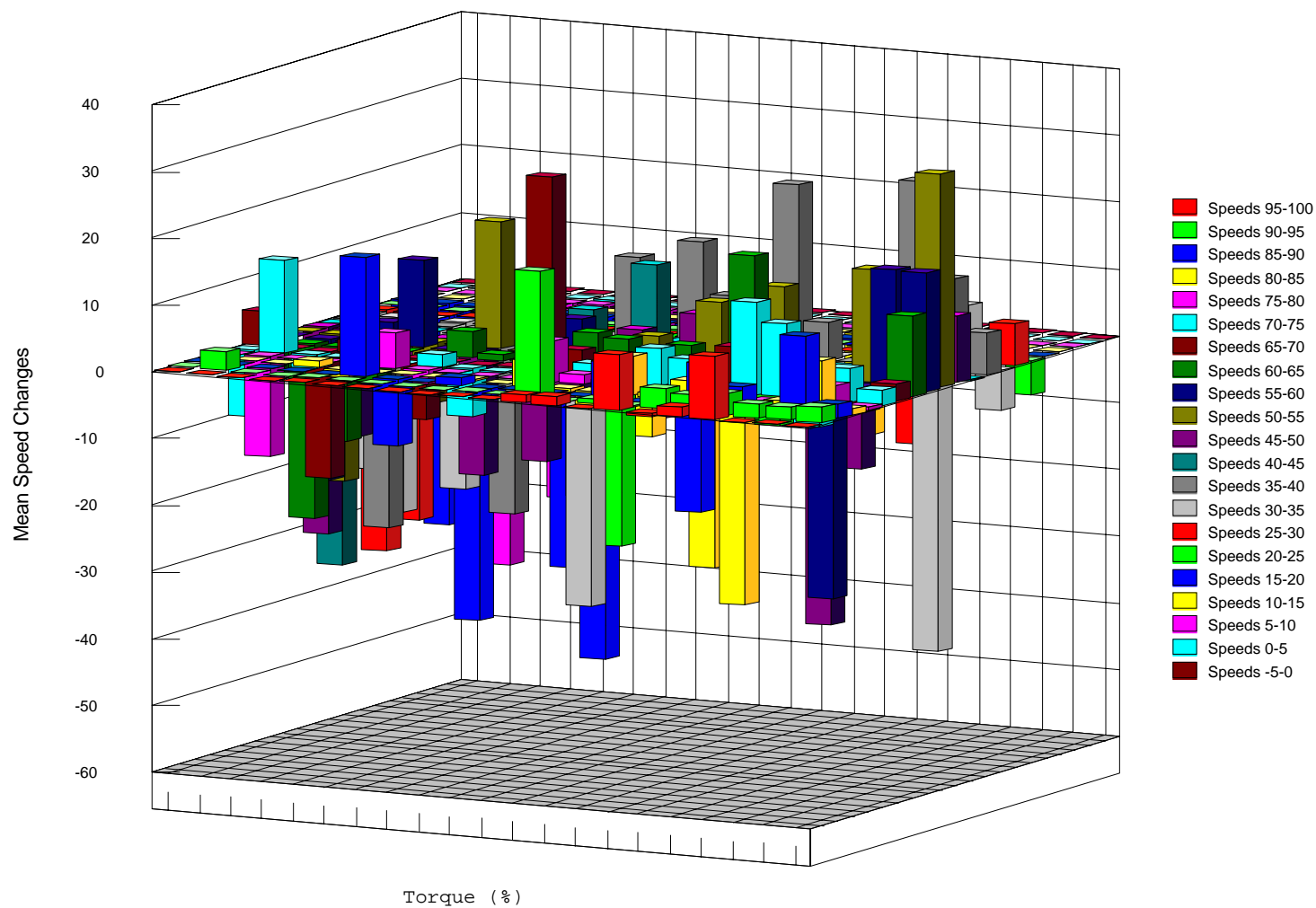
## Backhoe--Torque Steady State Std. Deviations



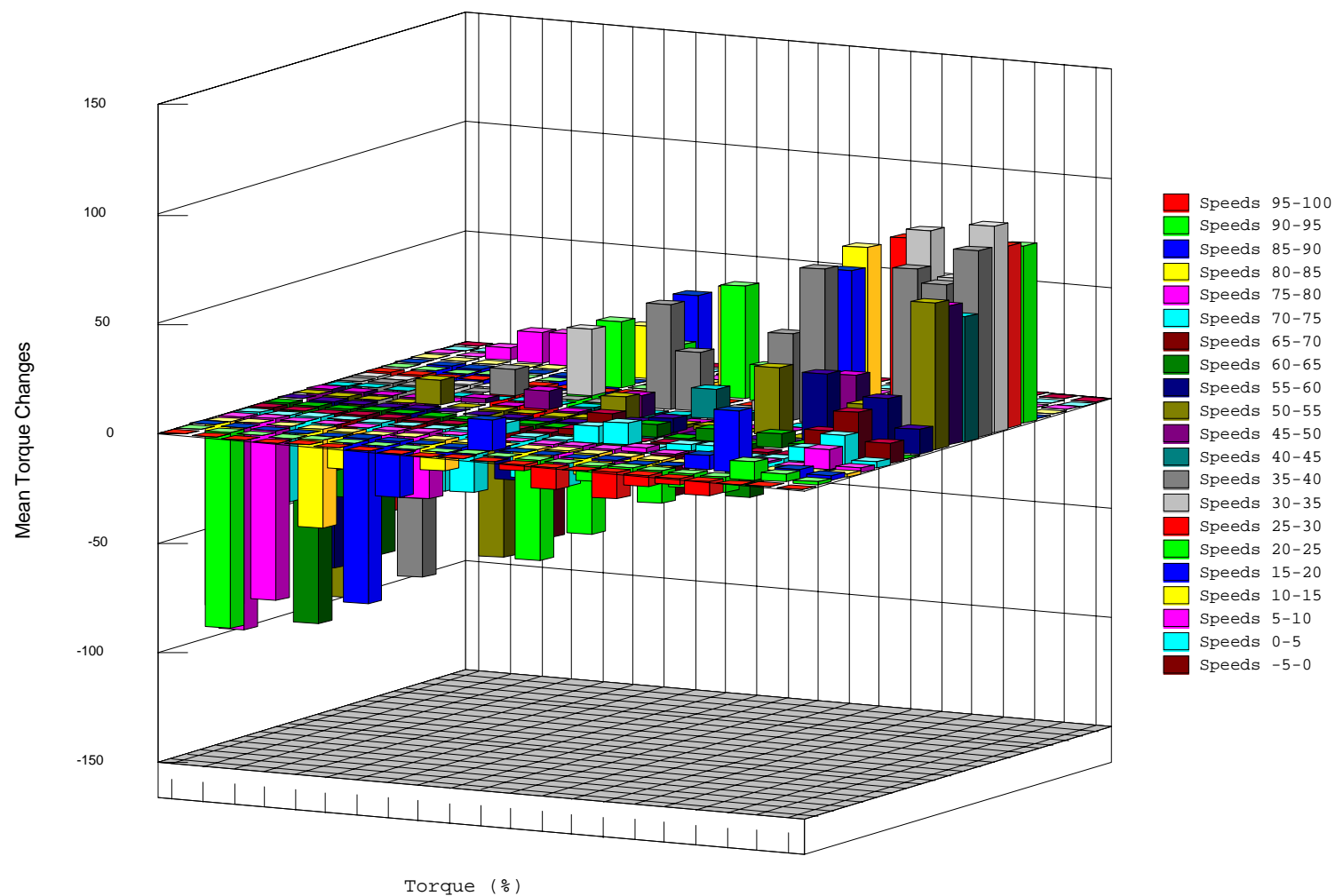
## Crawler--Counts



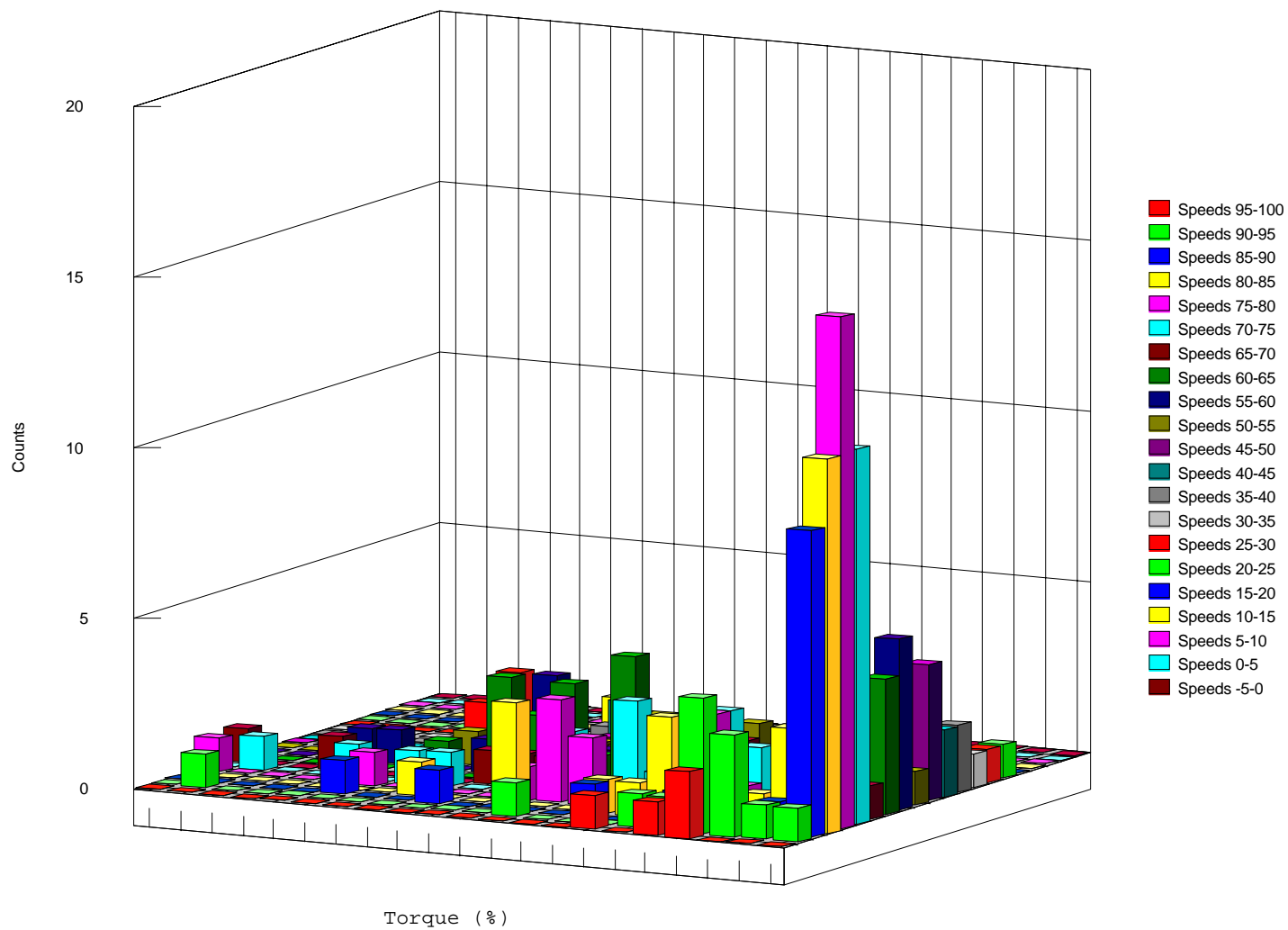
# Crawler--Mean Speed Changes



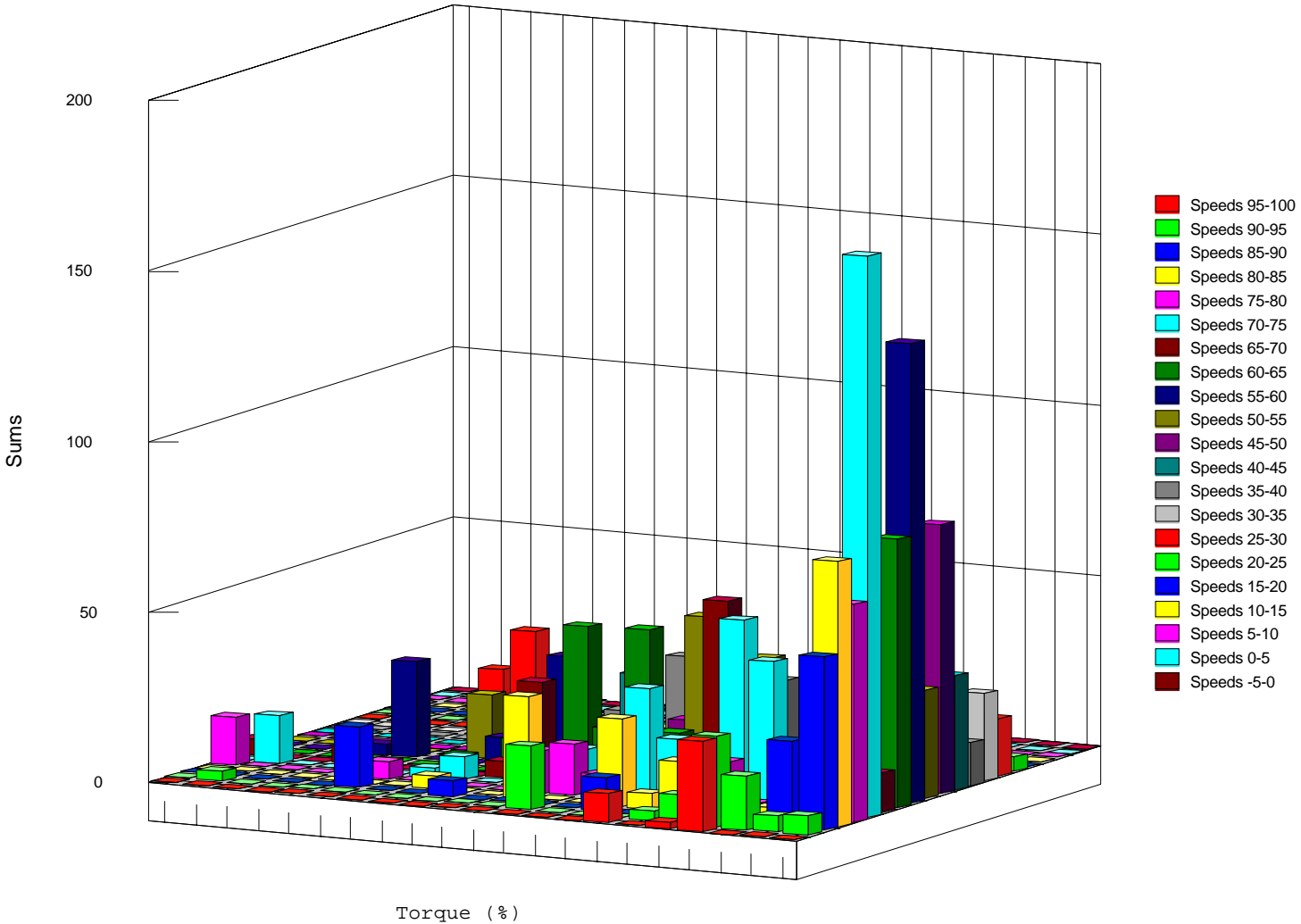
## Crawler--Mean Torque Changes



# Crawler--Speed Acceleration Counts

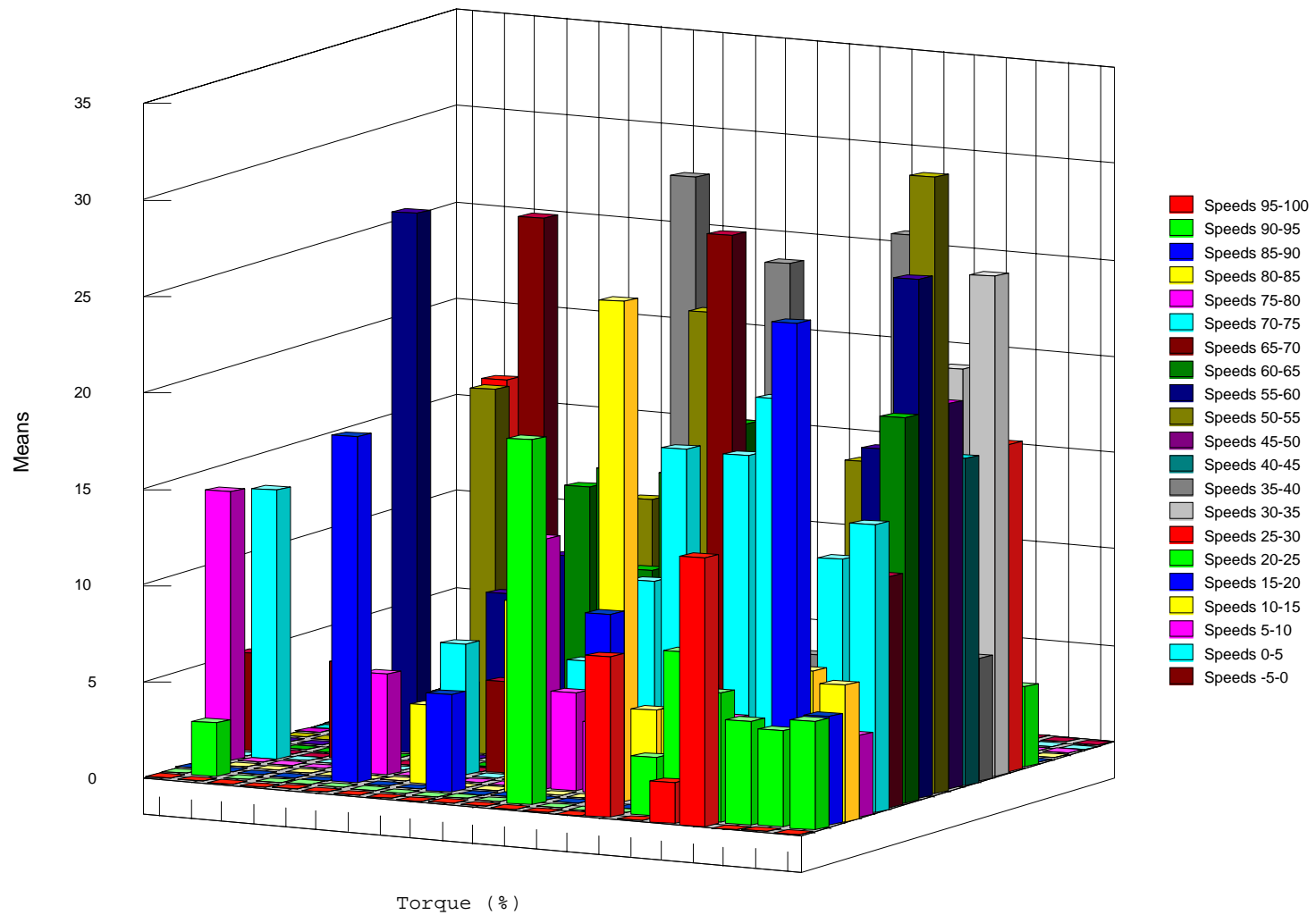


## Crawler--Speed Acceleration Sums

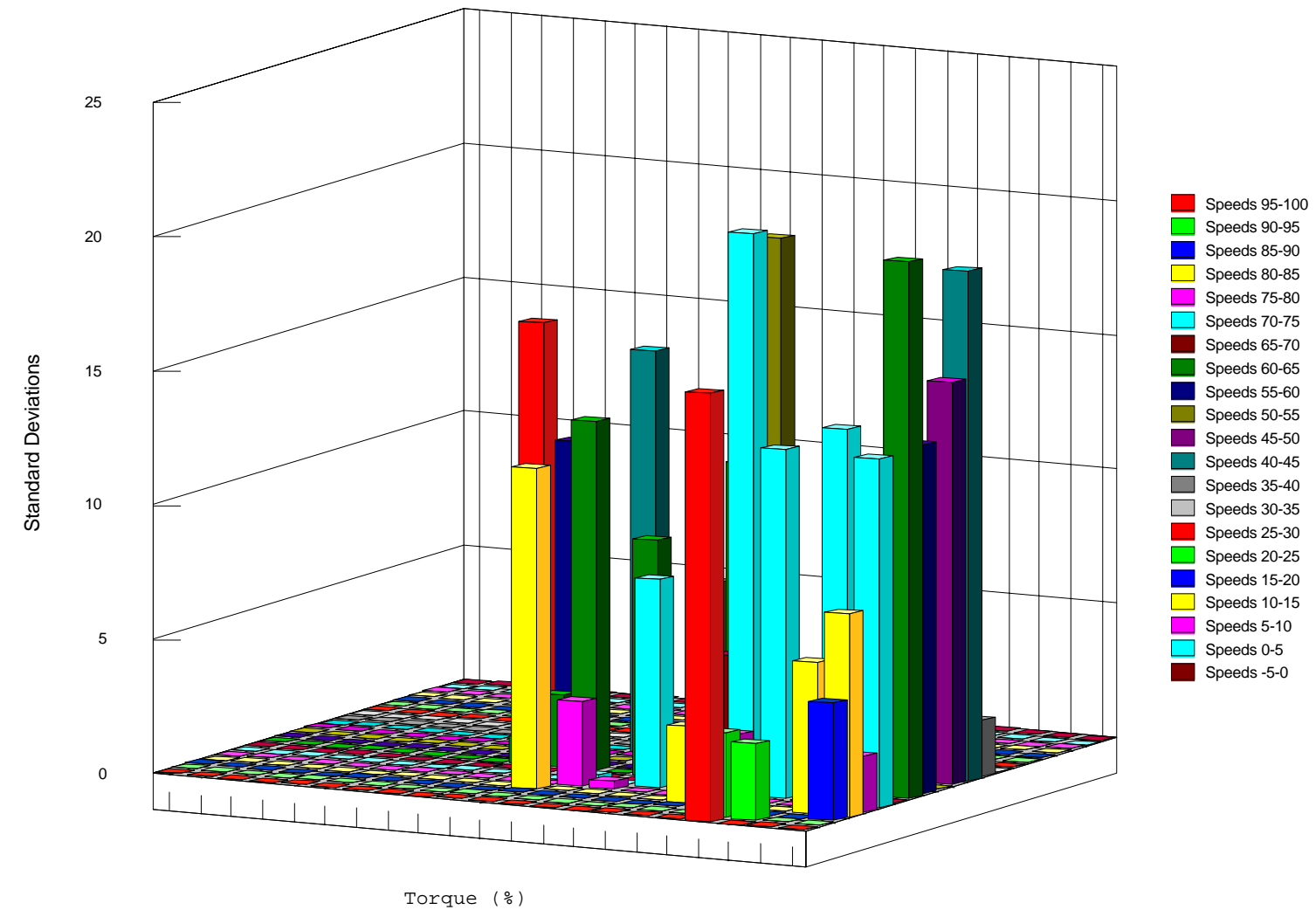




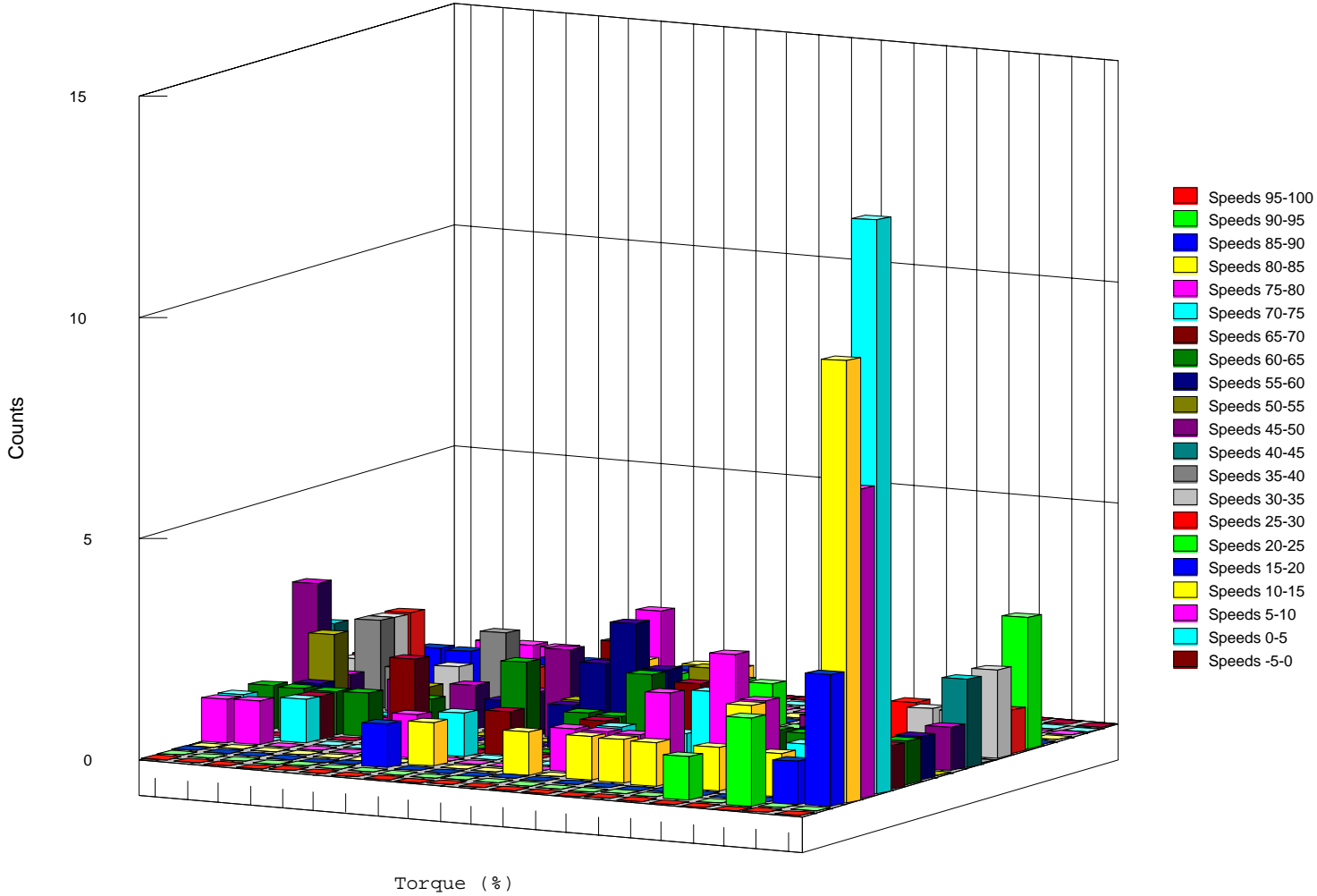
## Crawler--Speed Acceleration Means



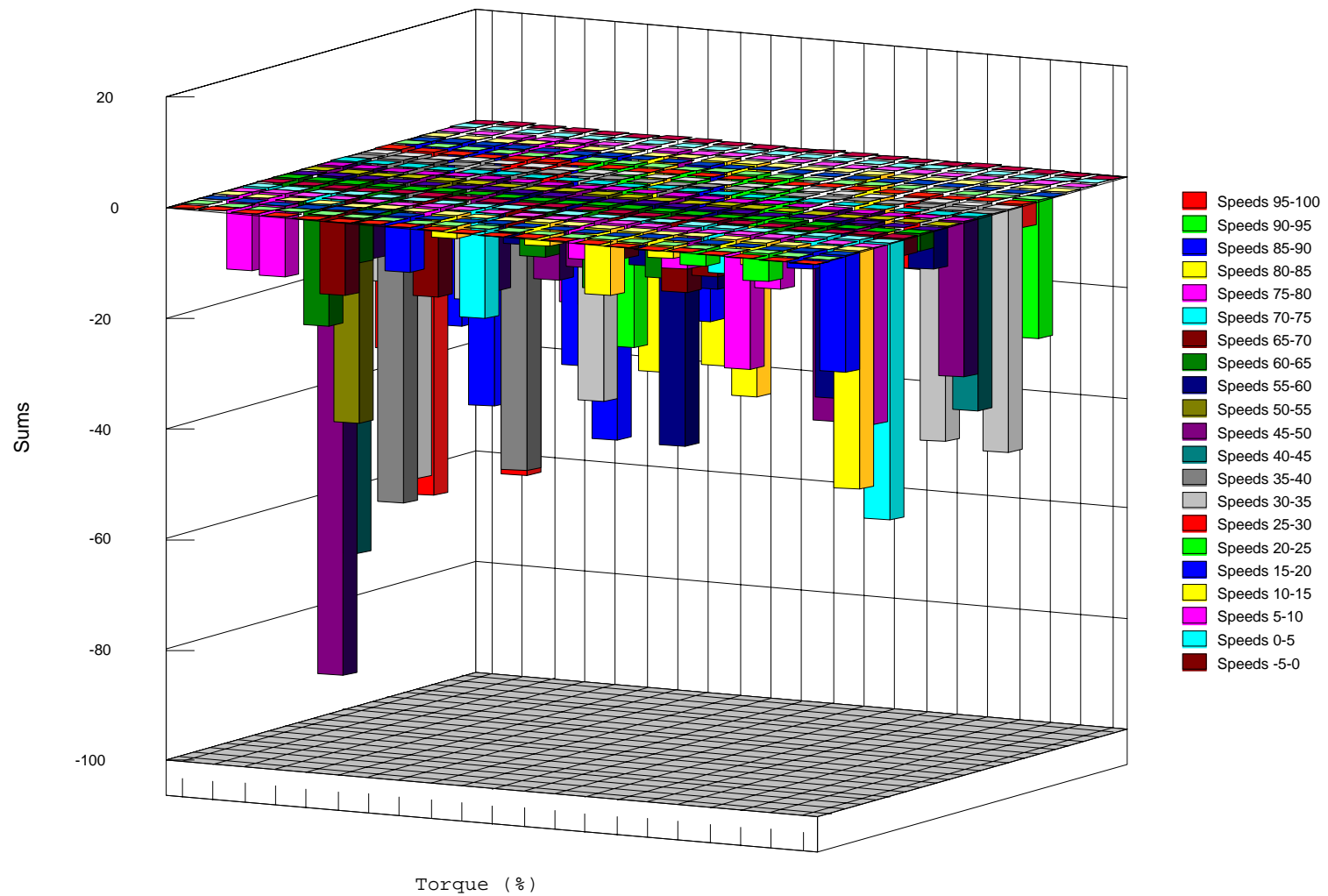
Crawler--Speed Acceleration Std. Deviations	
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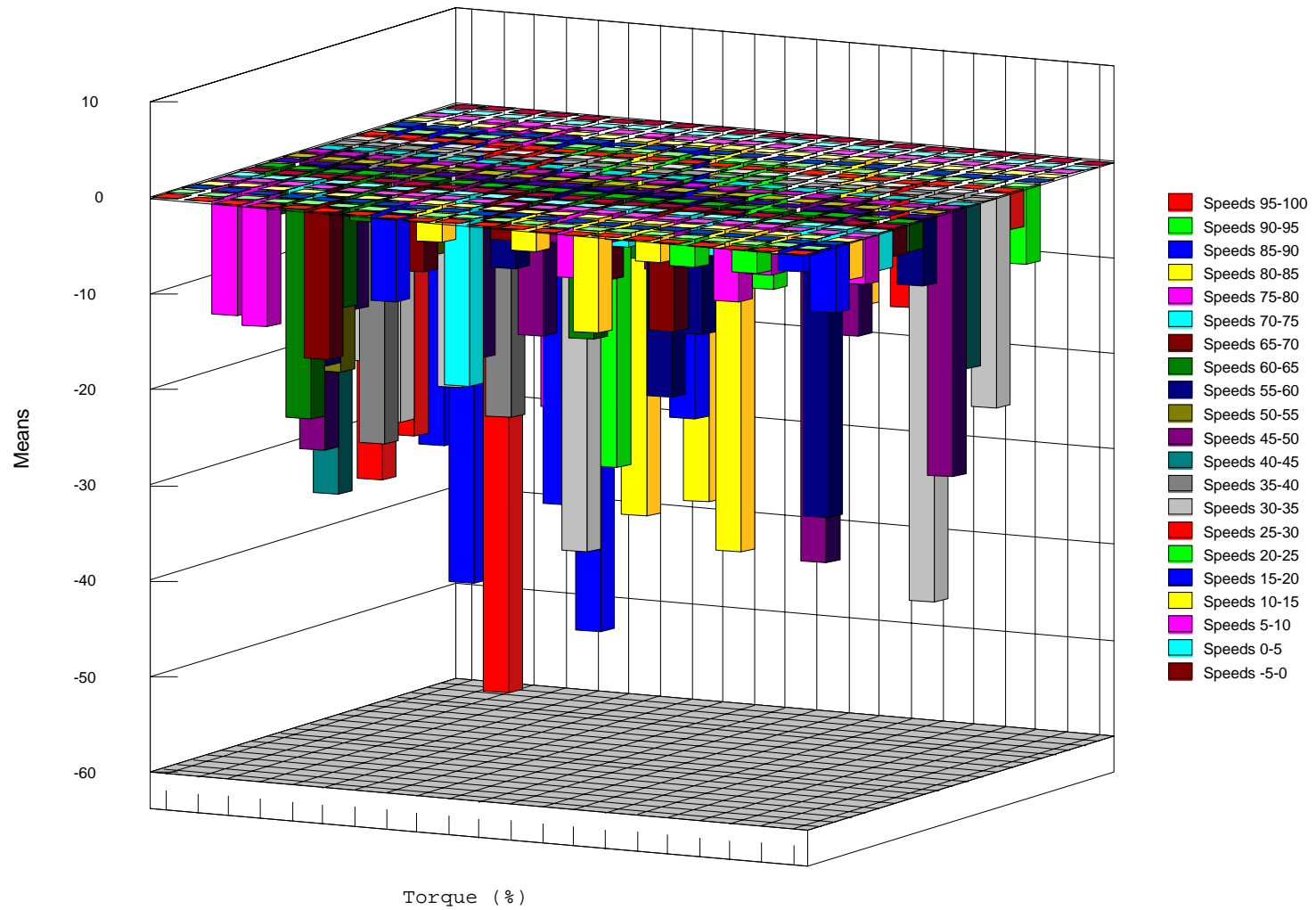
## Crawler--Speed Deceleration Counts



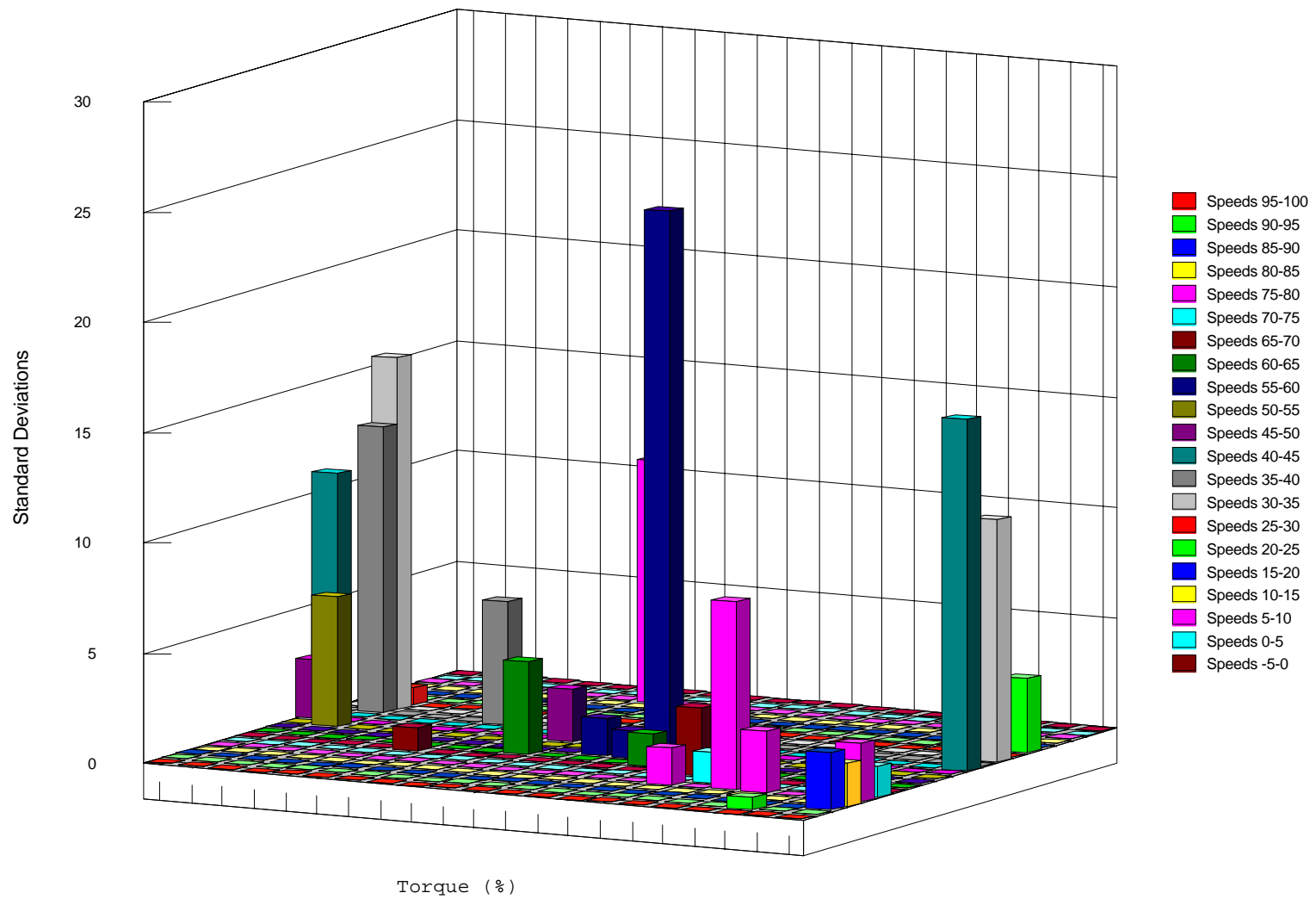
## Crawler--Speed Deceleration Sums



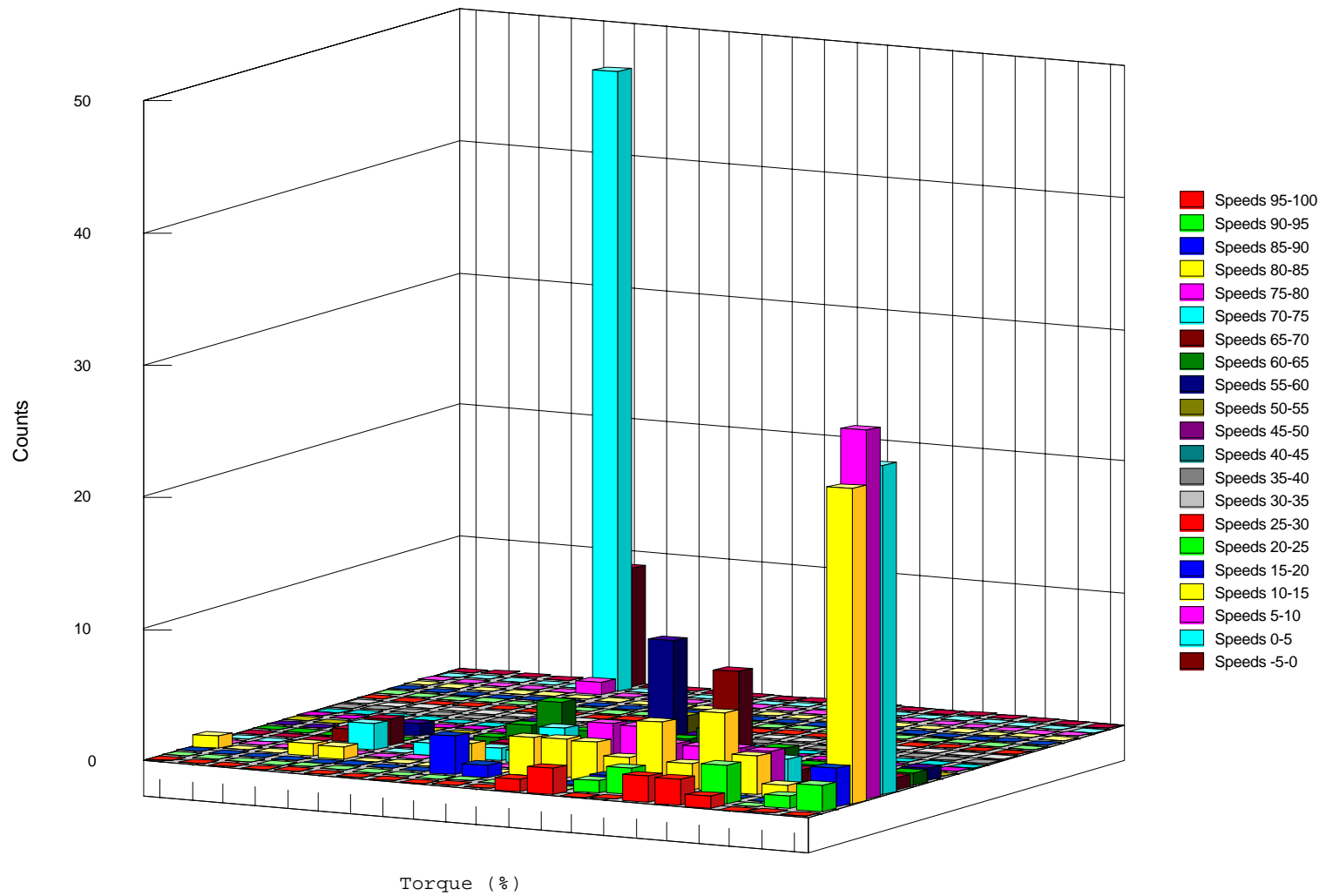
## Crawler--Speed Deceleration Means



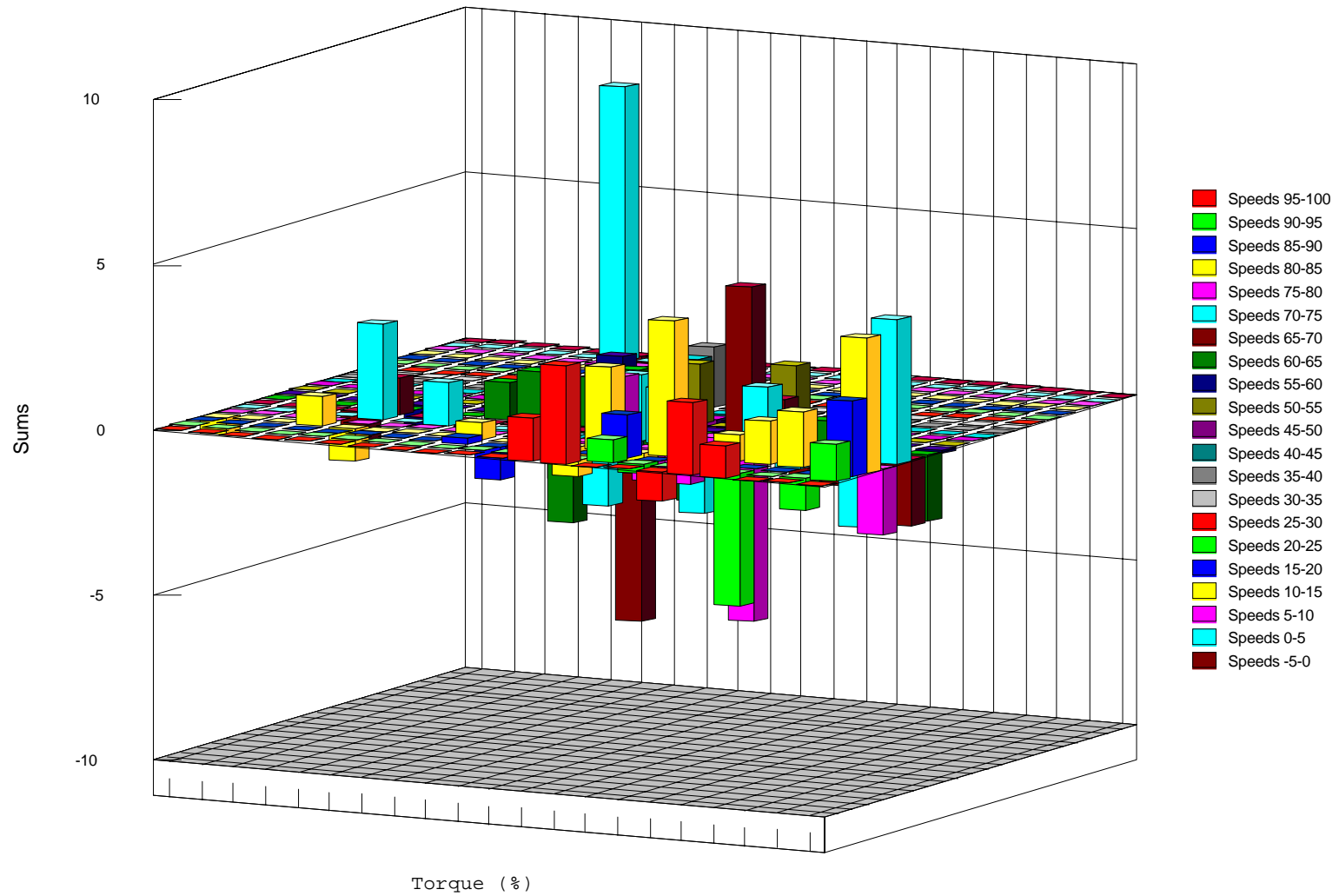
## Crawler--Speed Deceleration Std. Deviations



## Crawler--Speed Steady State Counts

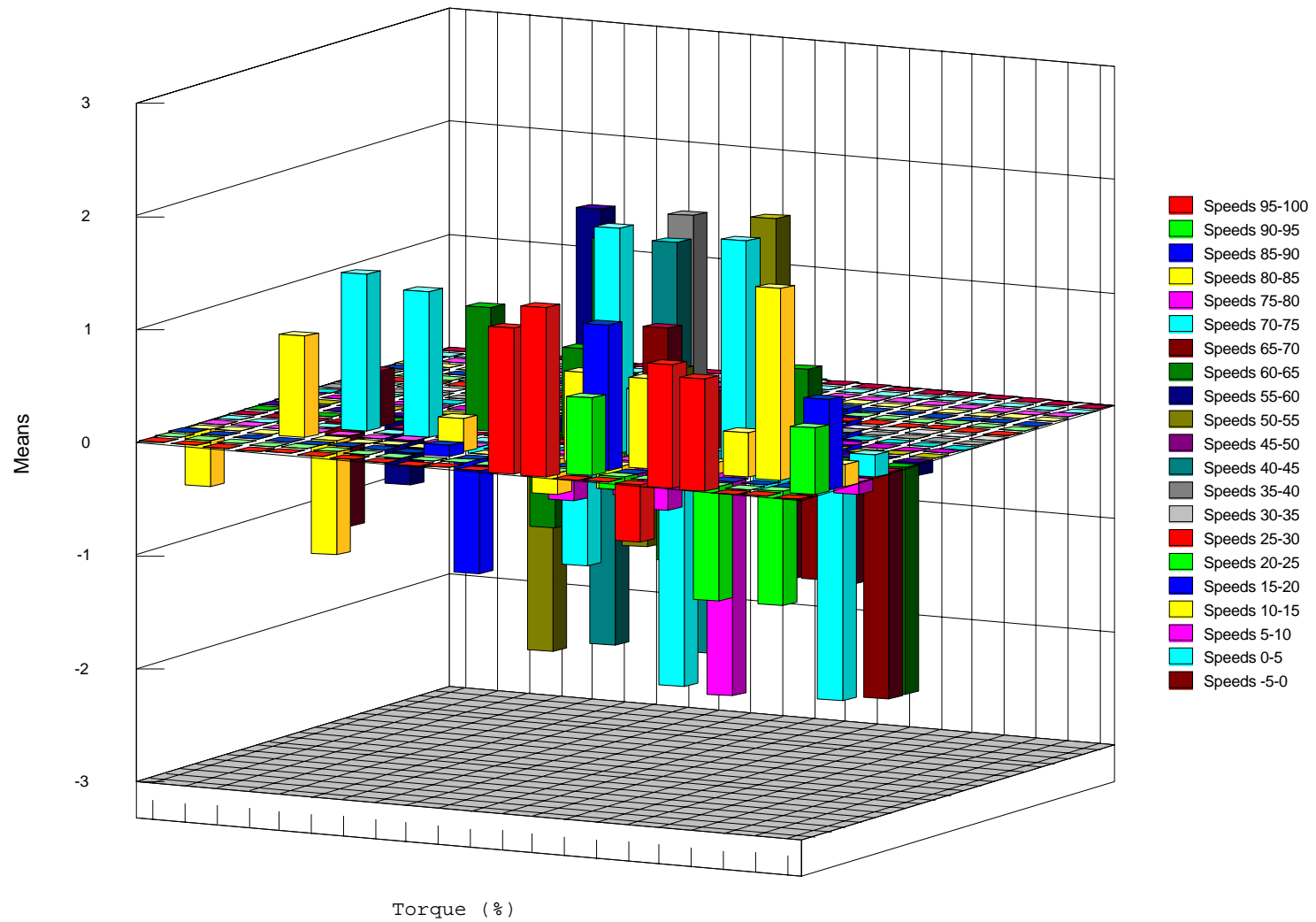


## Crawler--Speed Steady State Sums

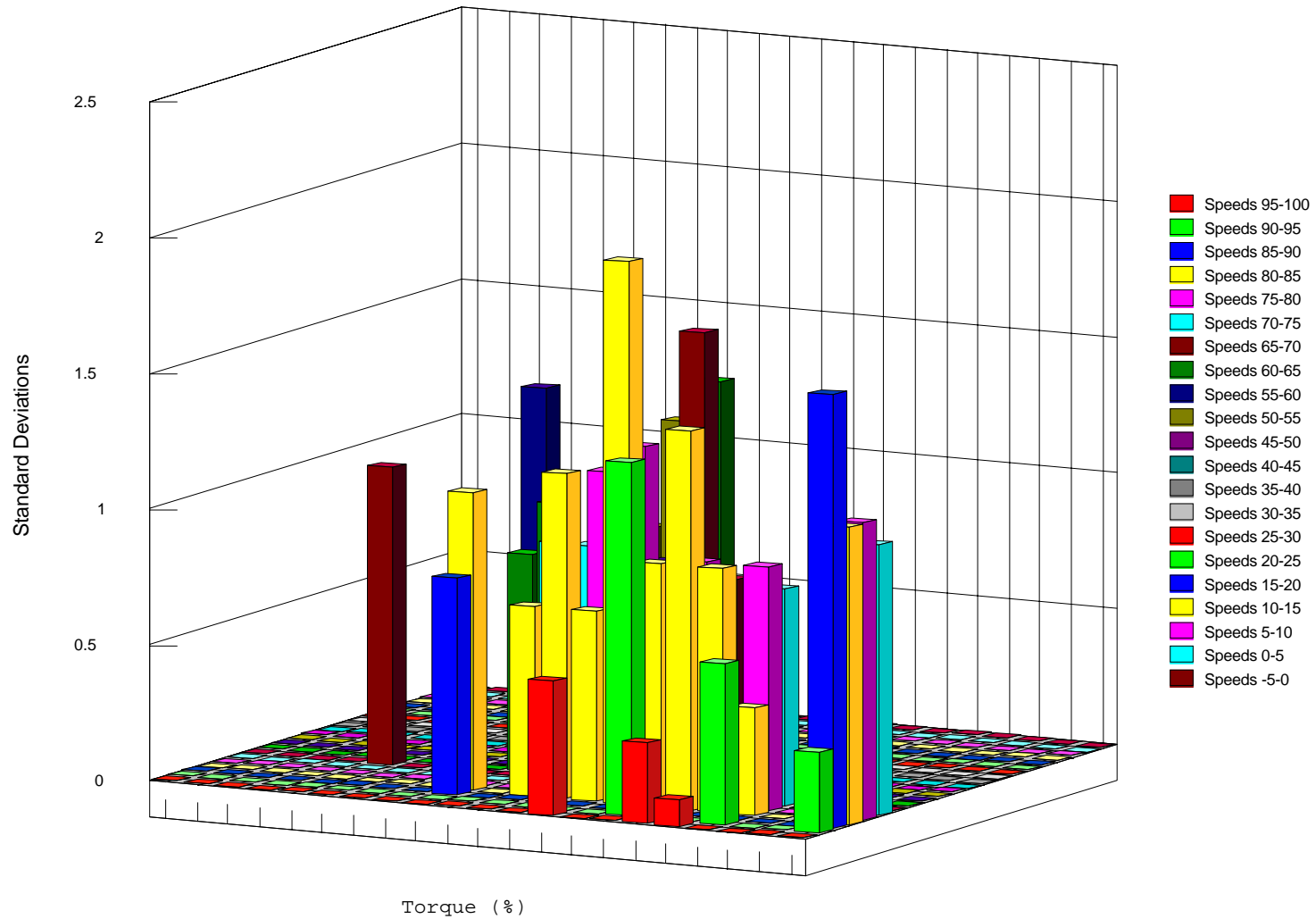




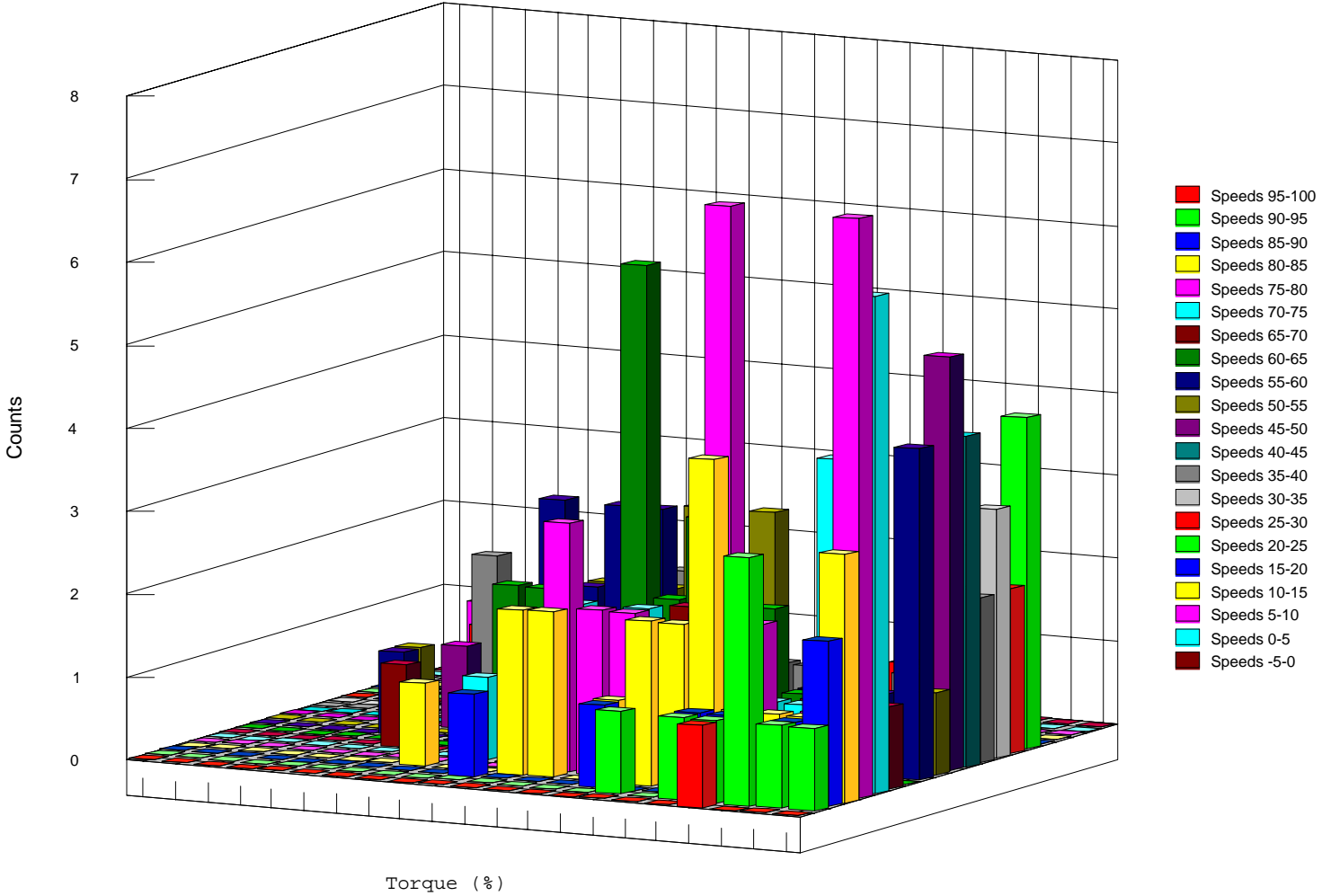
## Crawler--Speed Steady State Means



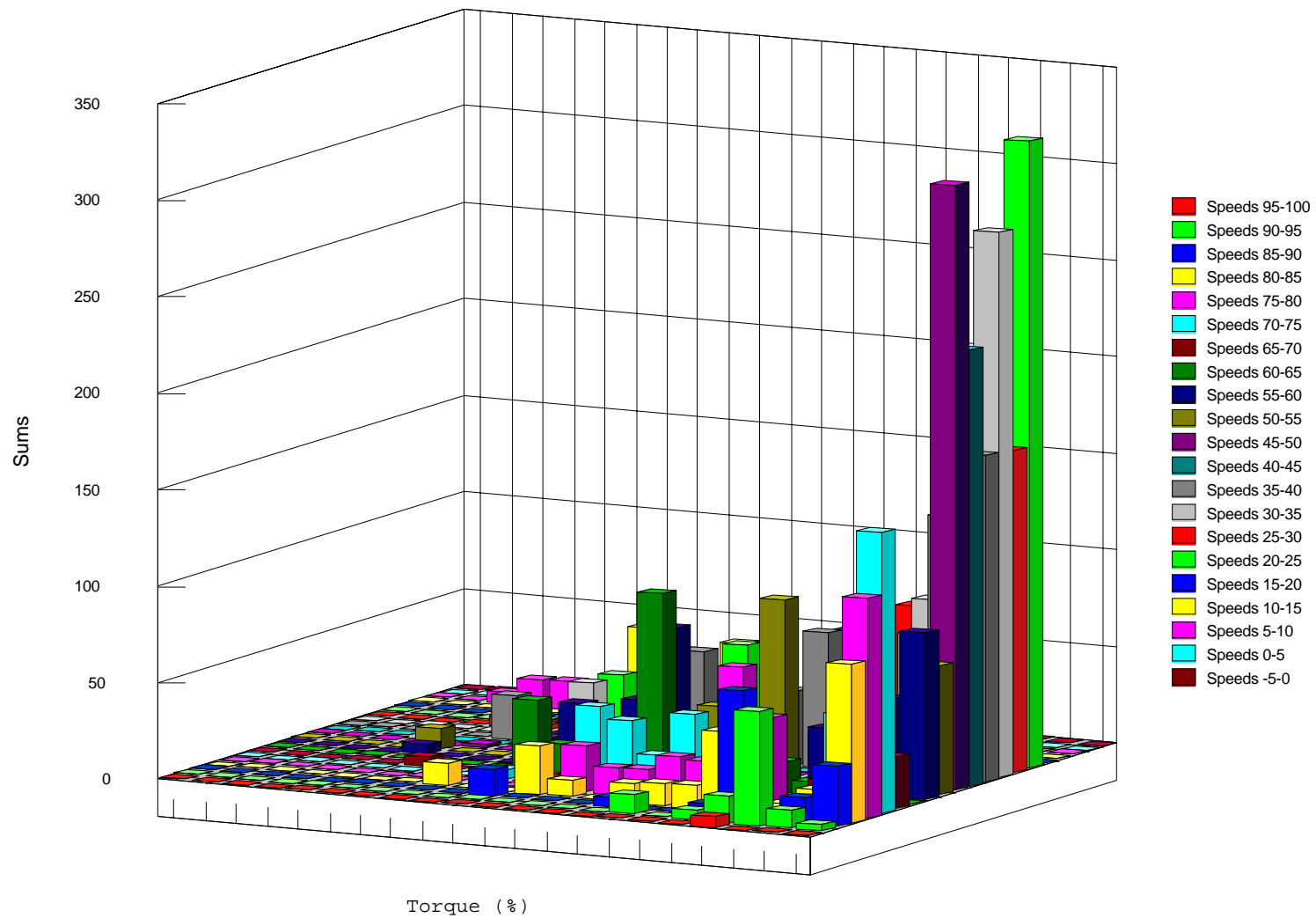
## Crawler--Steady State Std. Deviations



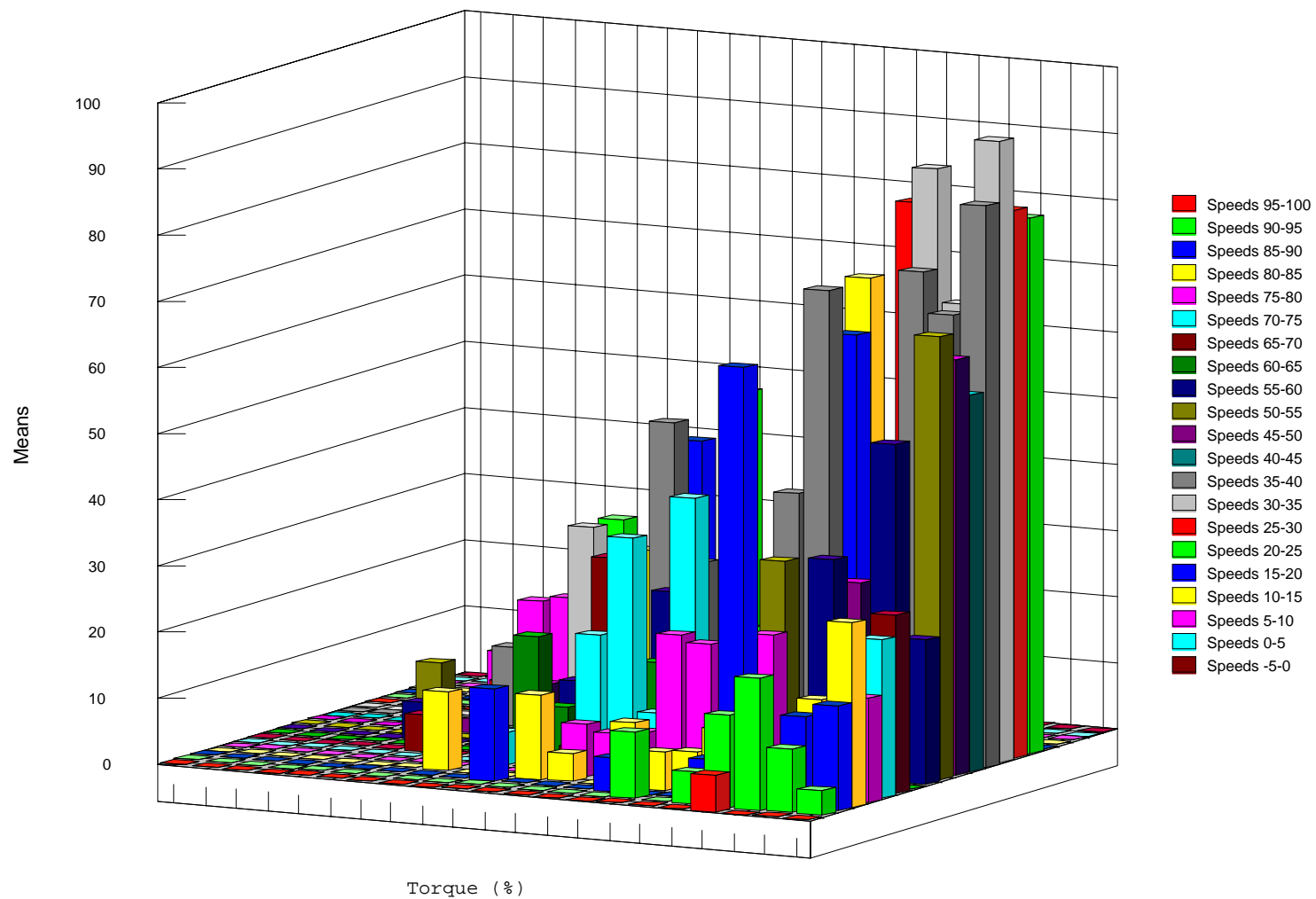
## Crawler--Torque Acceleration Counts



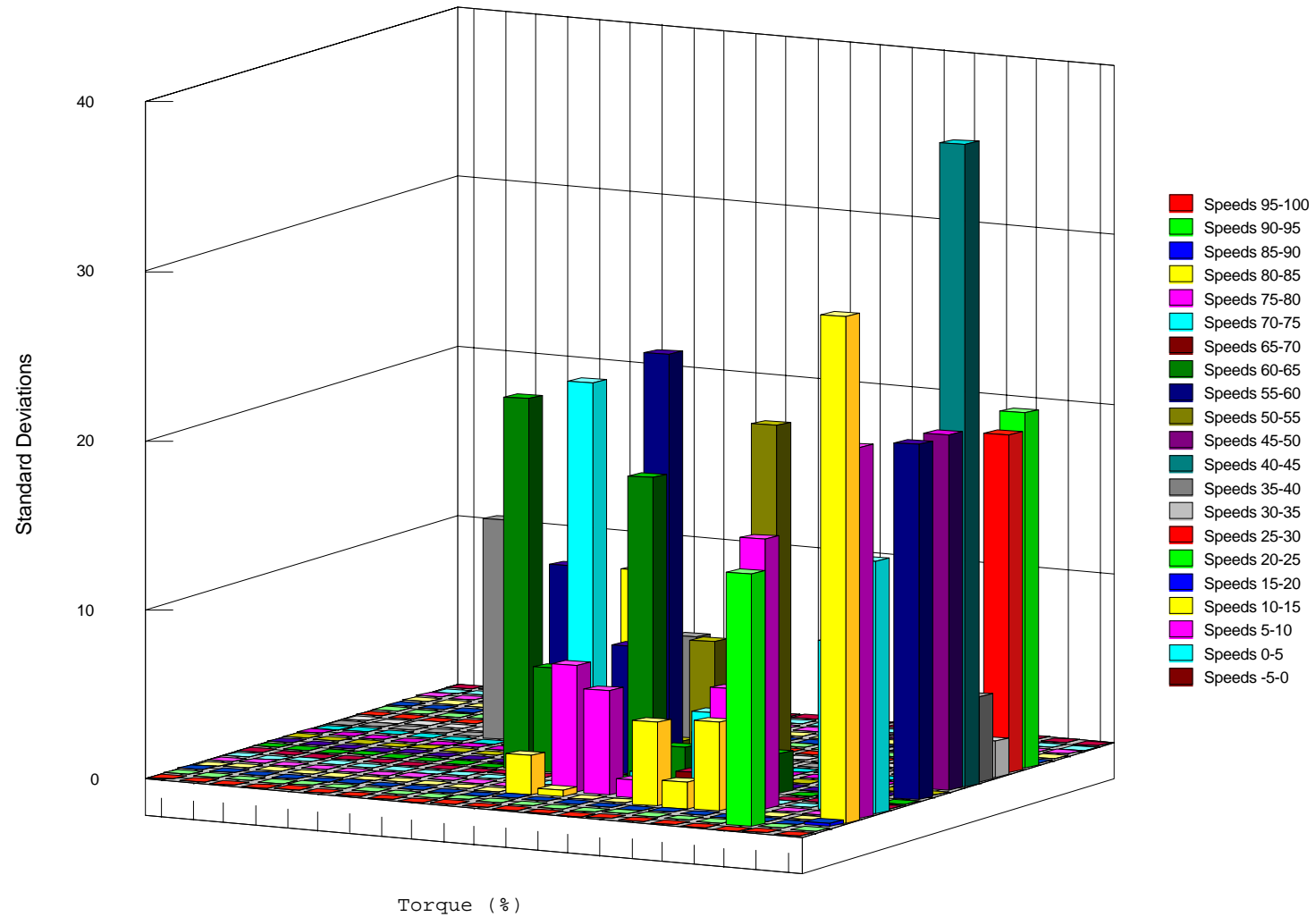
## Crawler--Torque Acceleration Sums



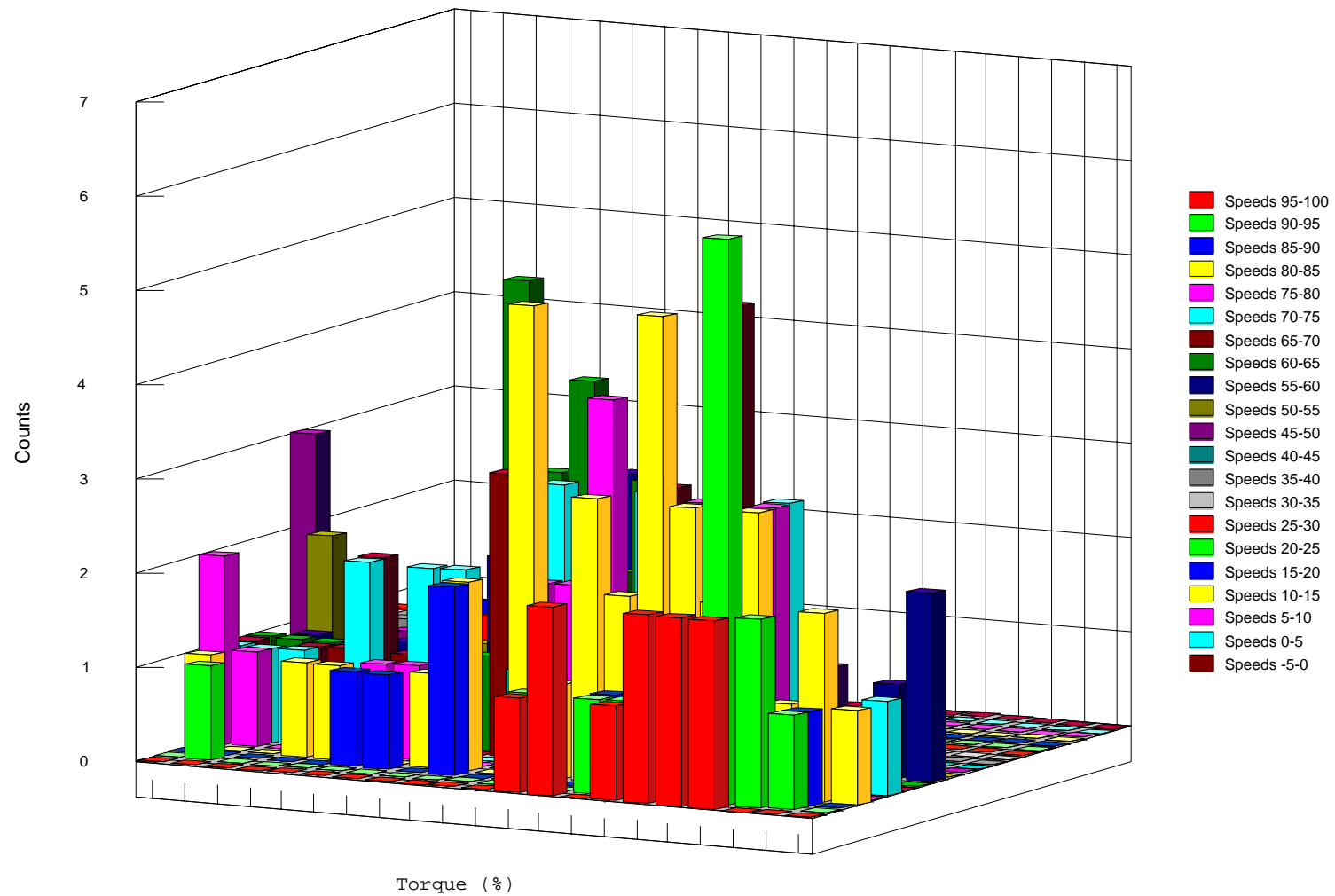
## Crawler--Torque Acceleration Means



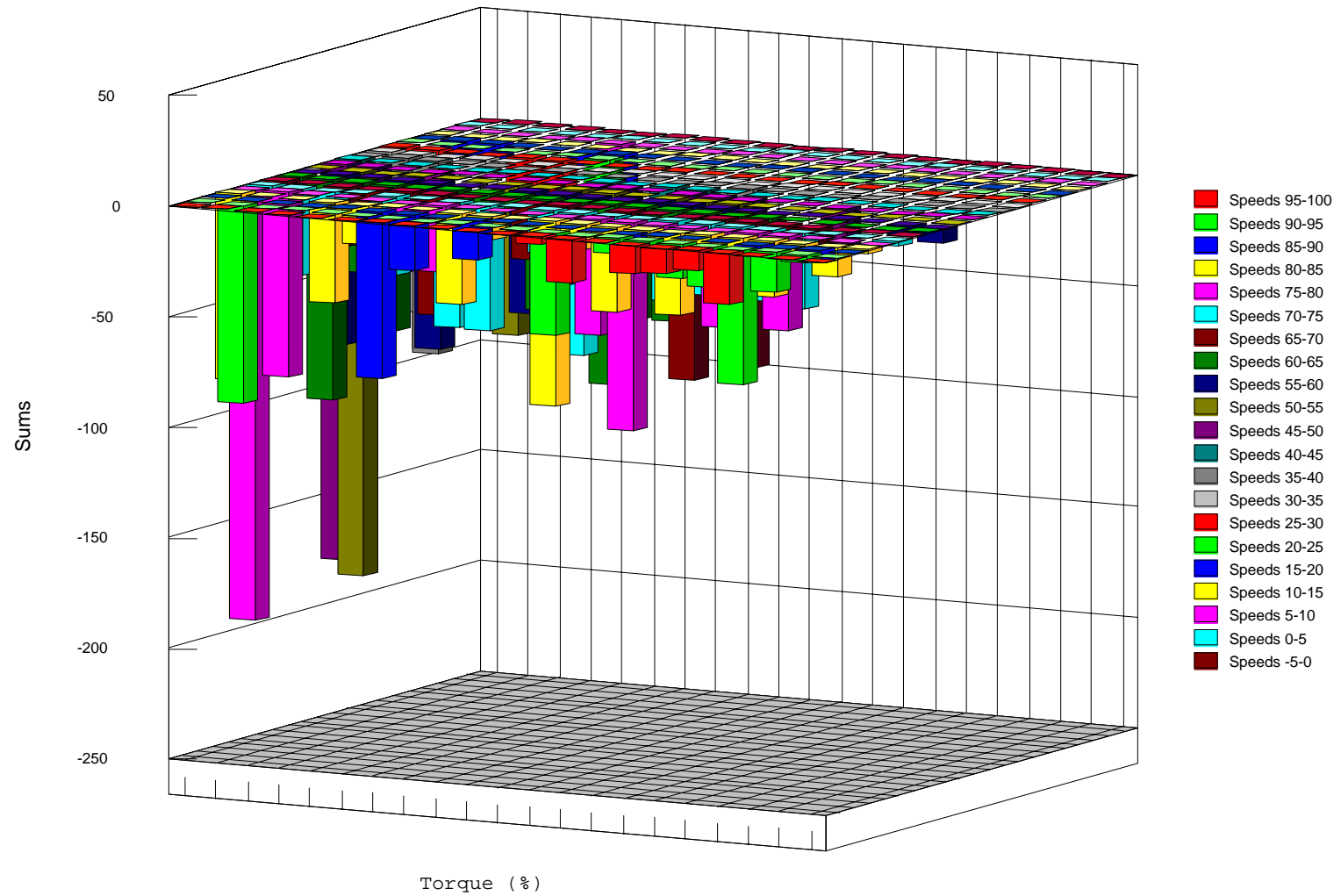
Crawler--Torque Acceleration Std. Deviations	
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## Crawler--Torque Deceleration Counts

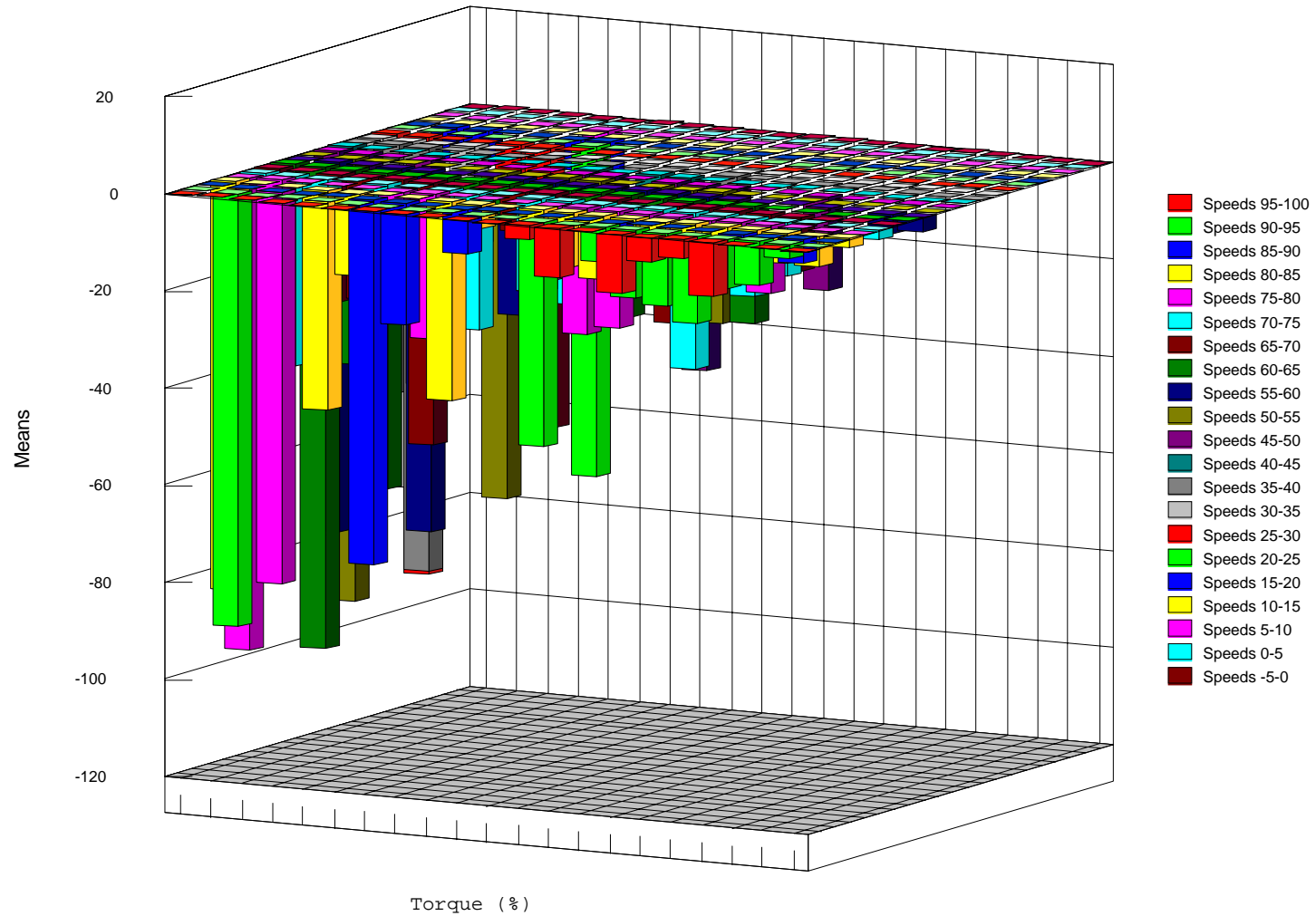


## Crawler--Torque Deceleration Sums

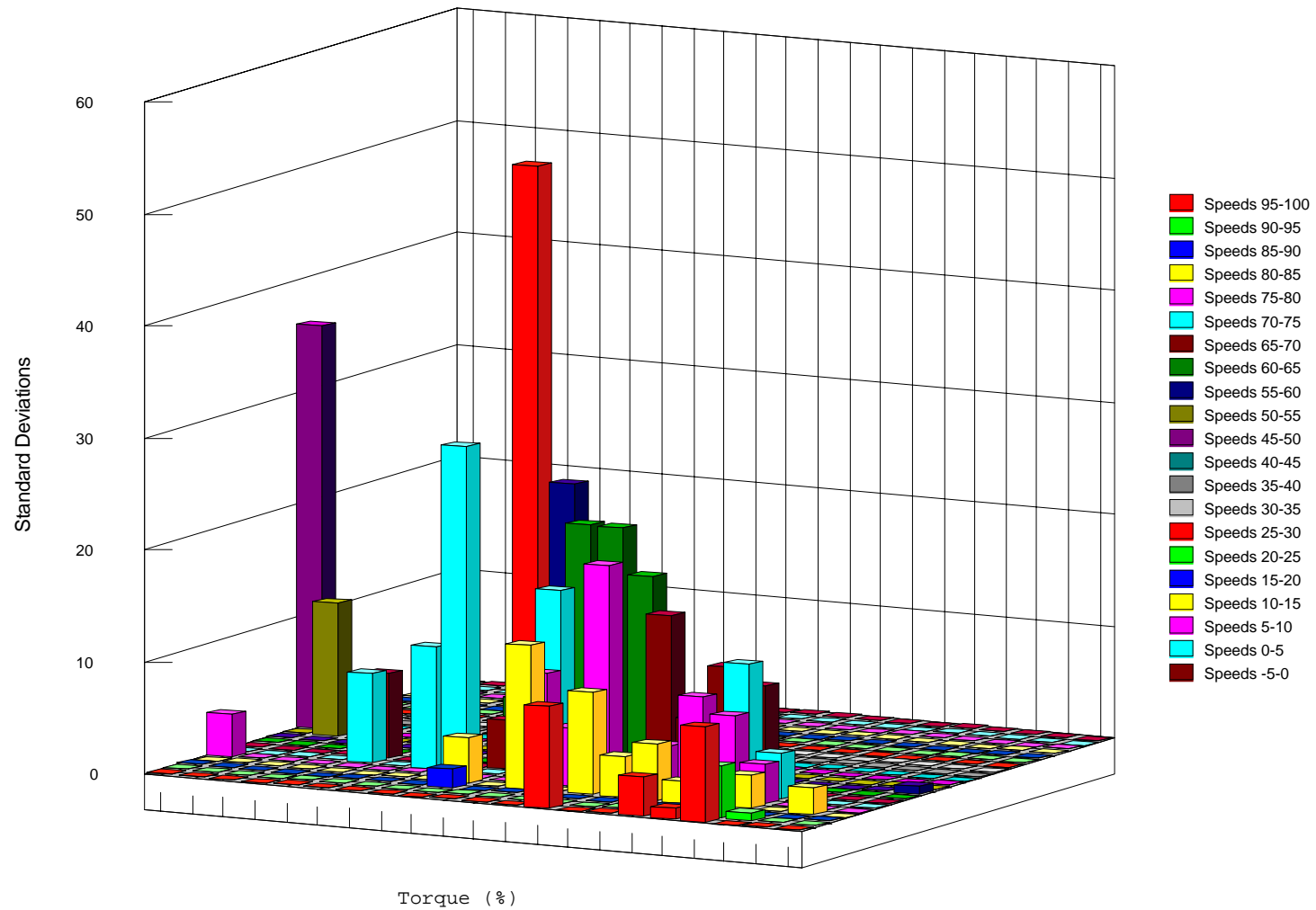




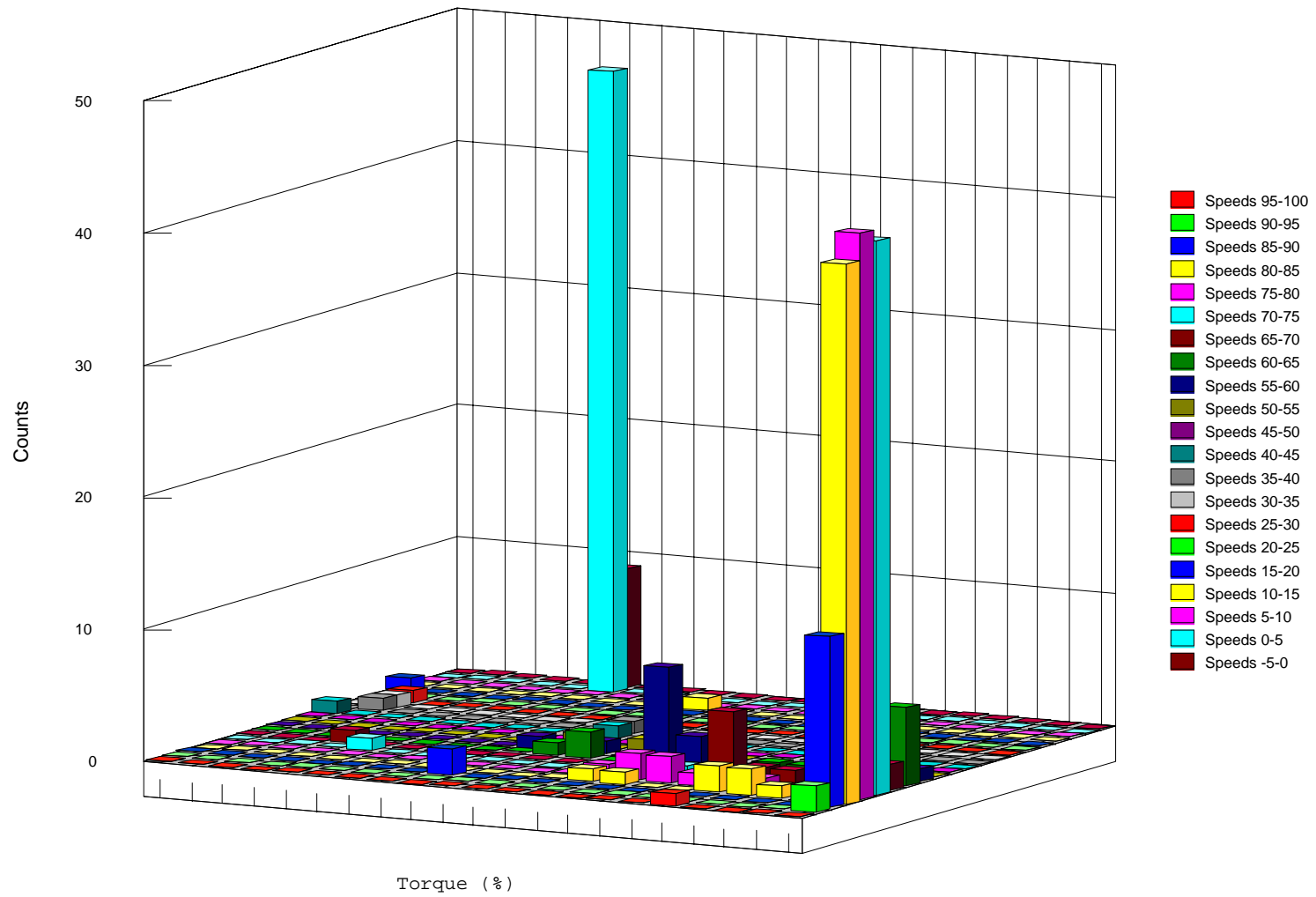
## Crawler--Torque Deceleration Means



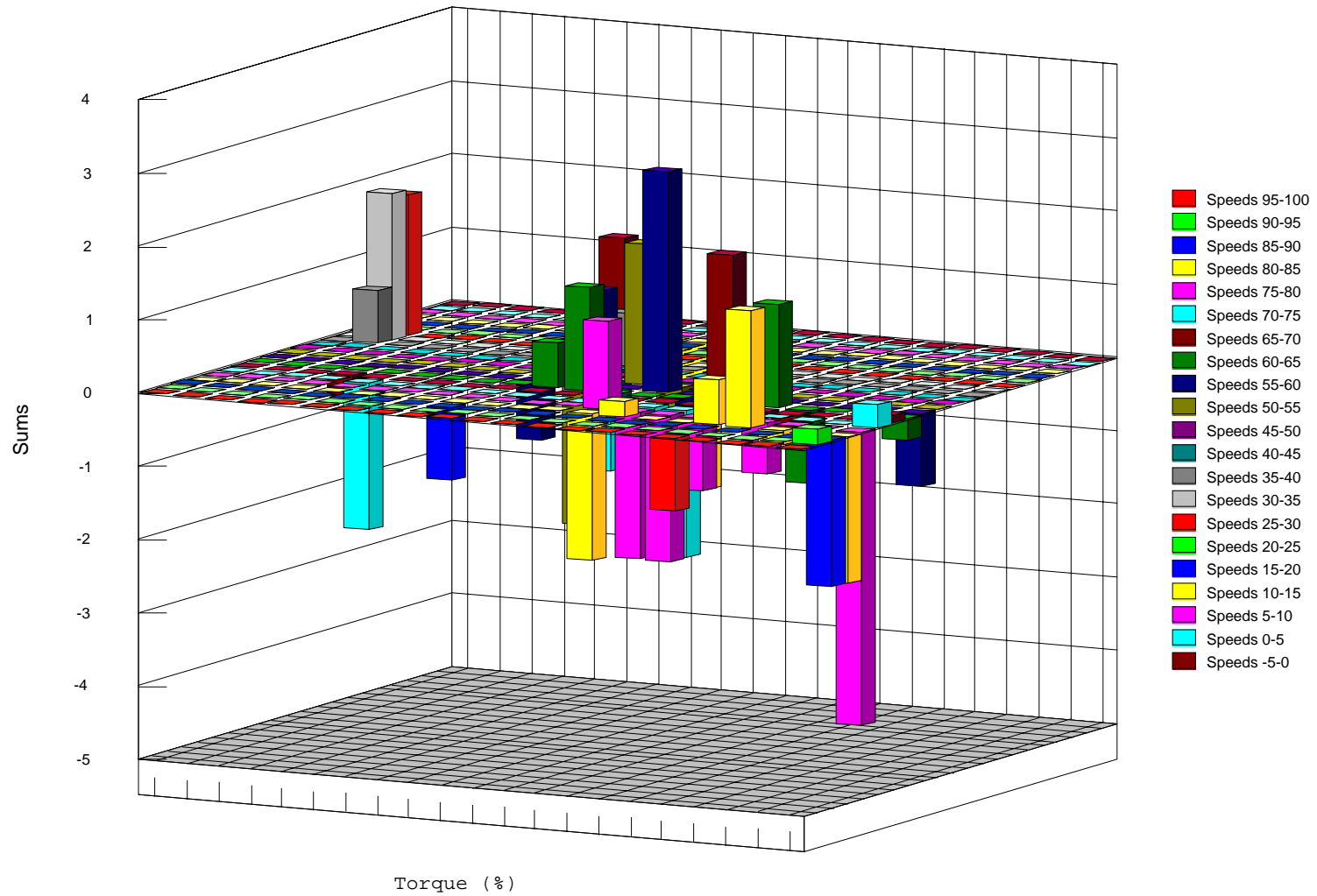
Crawler--Torque Deceleration Std. Deviations	
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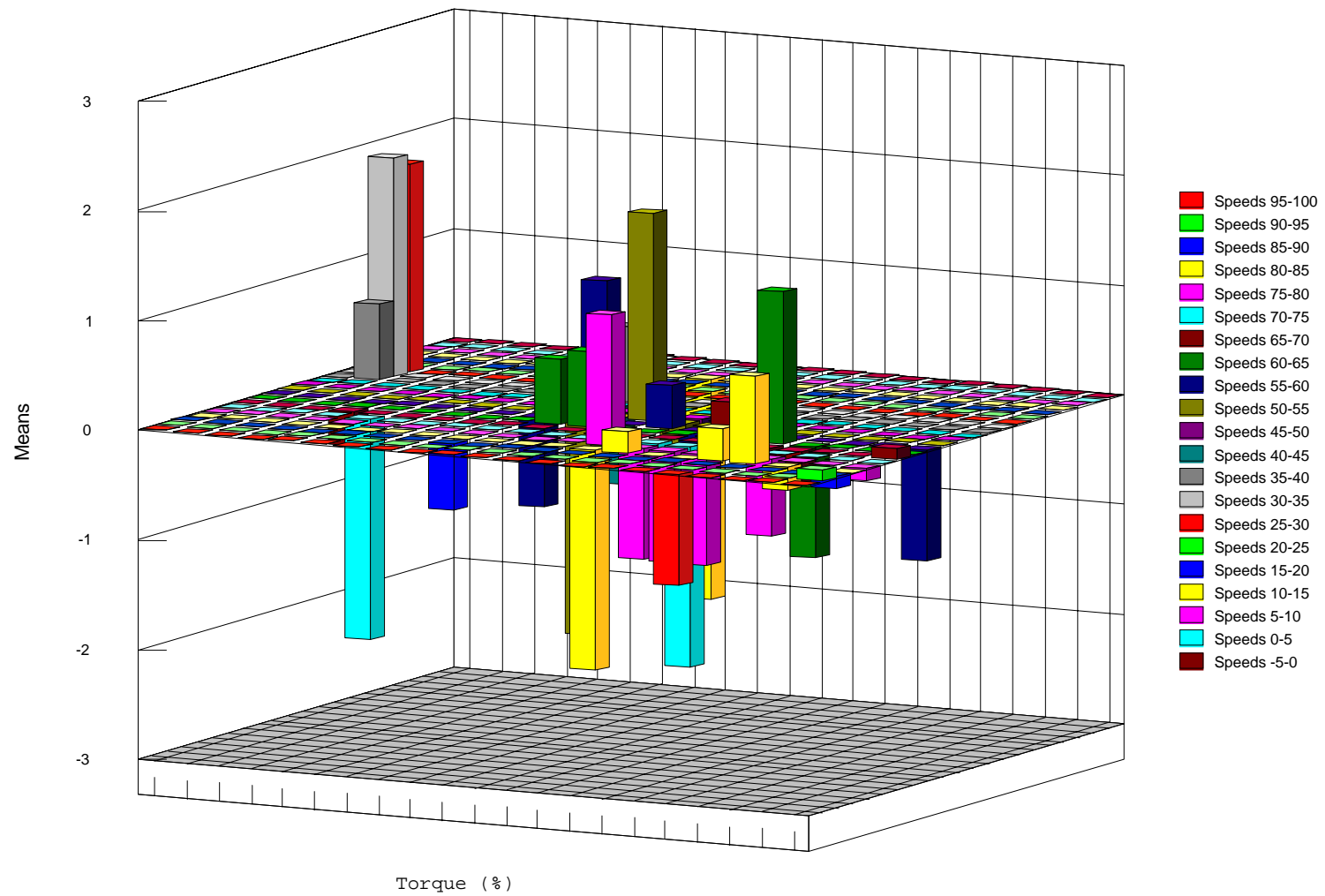
## Crawler--Torque Steady State Counts



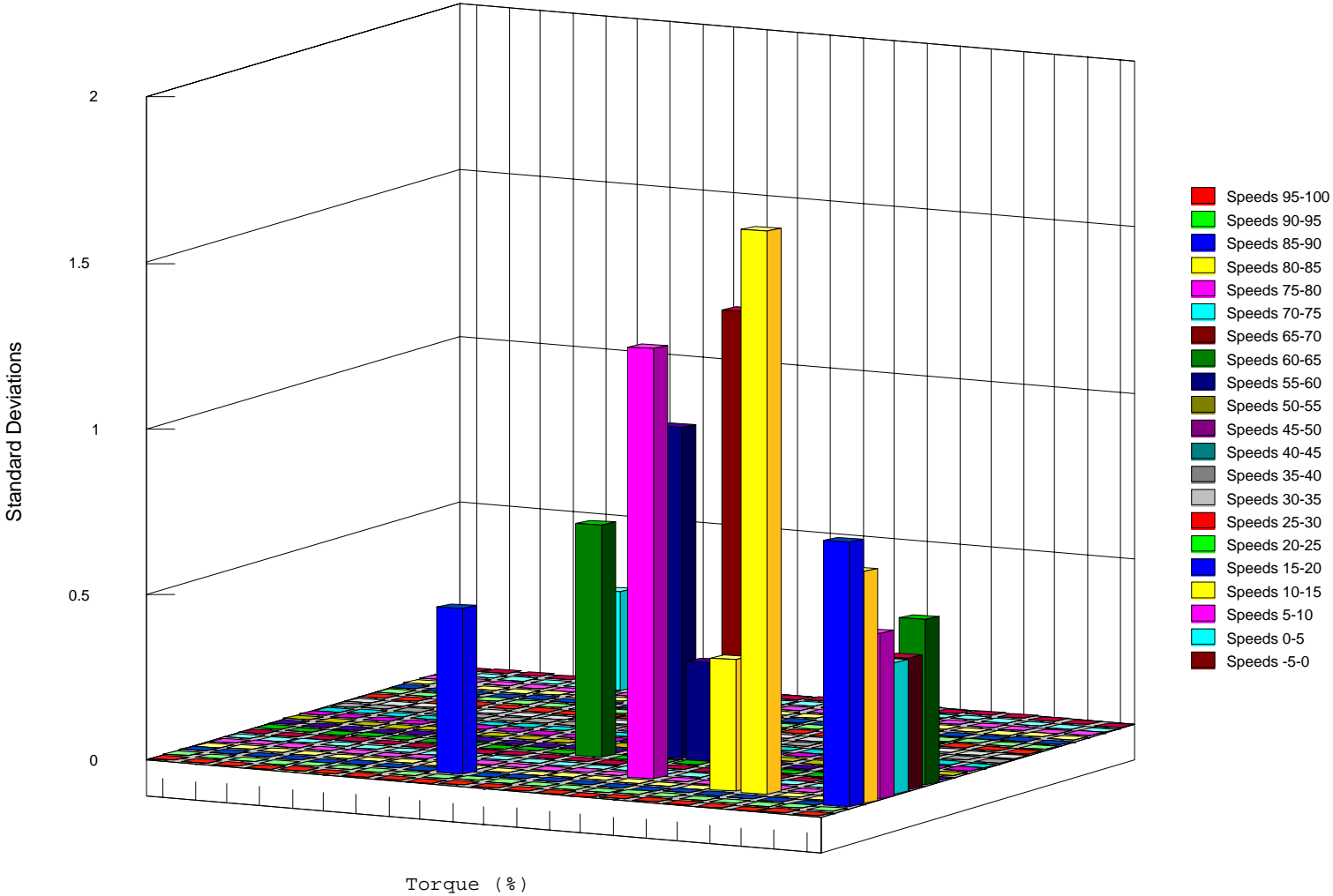
## Crawler--Torque Steady State Sums



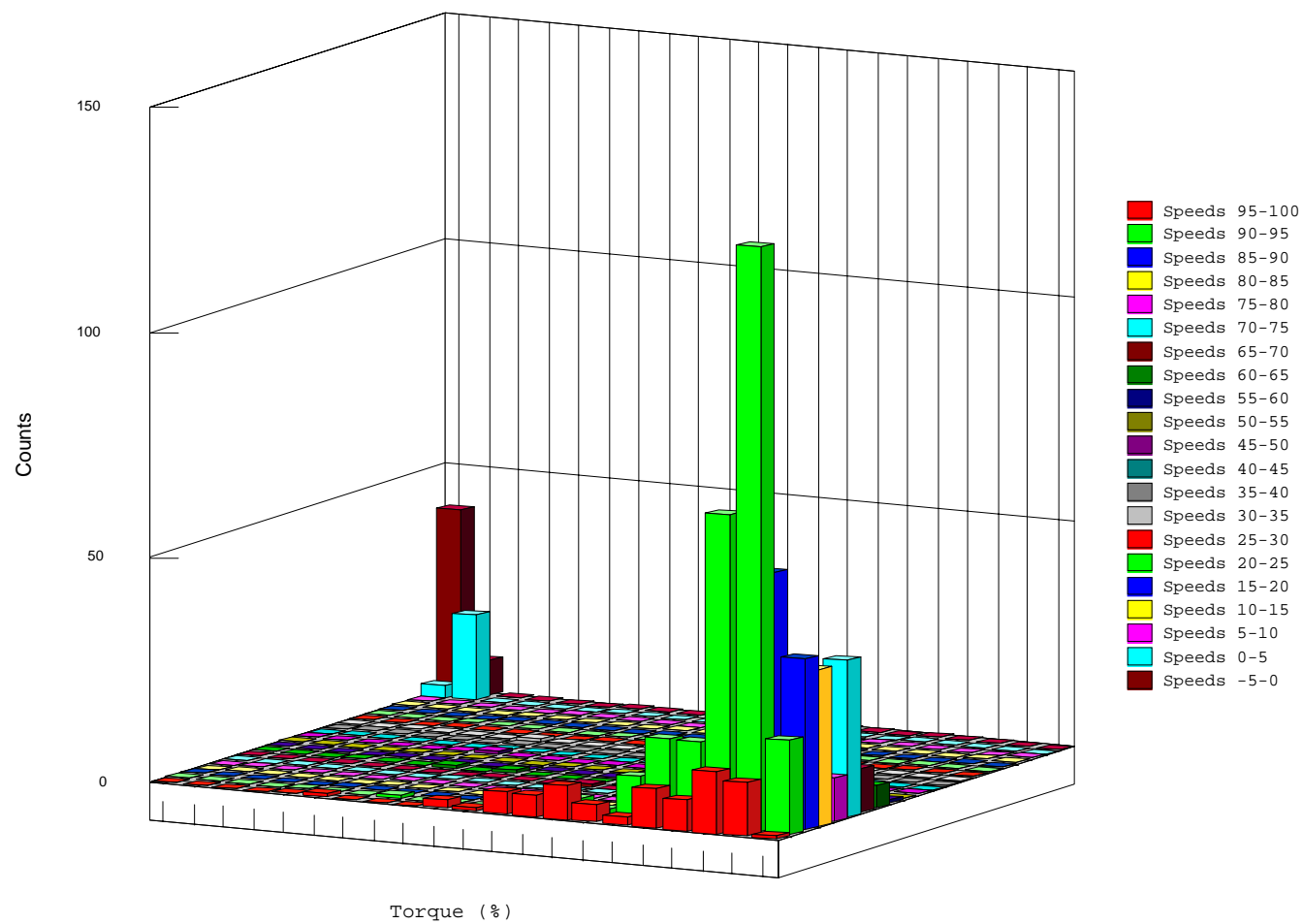
## Crawler--Torque Steady State Means



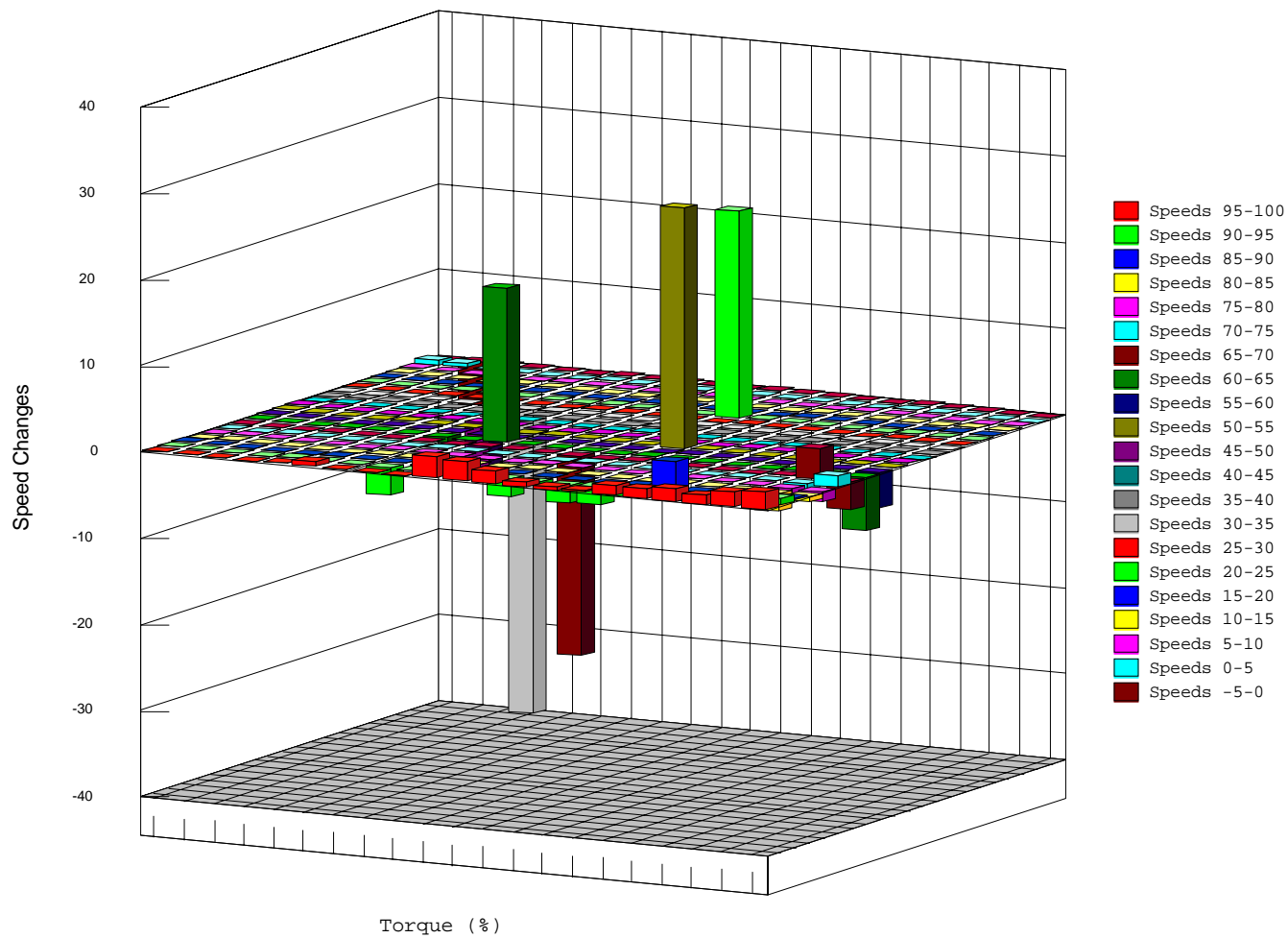
Crawler--Torque Steady State Std. Deviations	
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Agtract--Counts

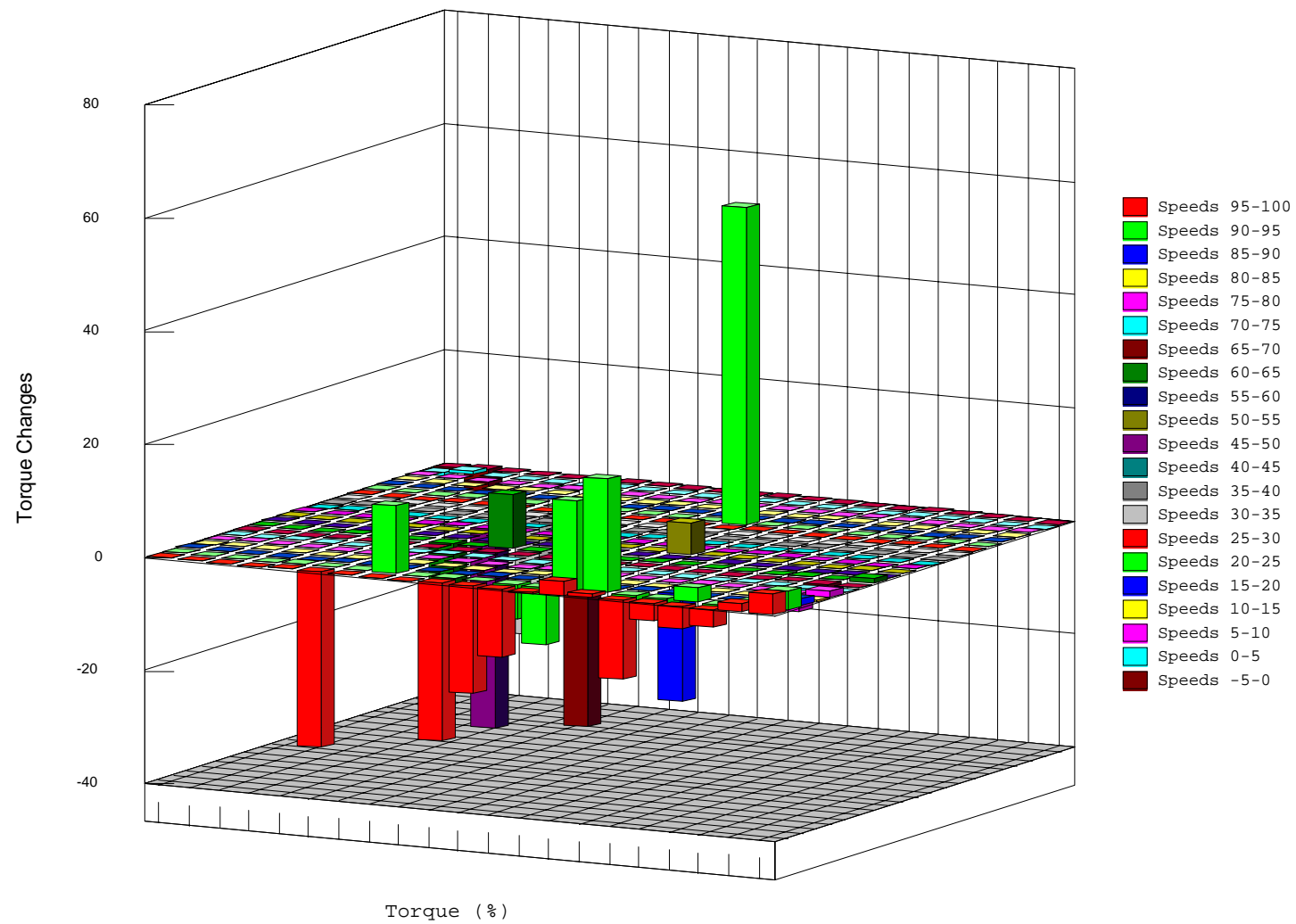


Agtract--Mean Speed Changes

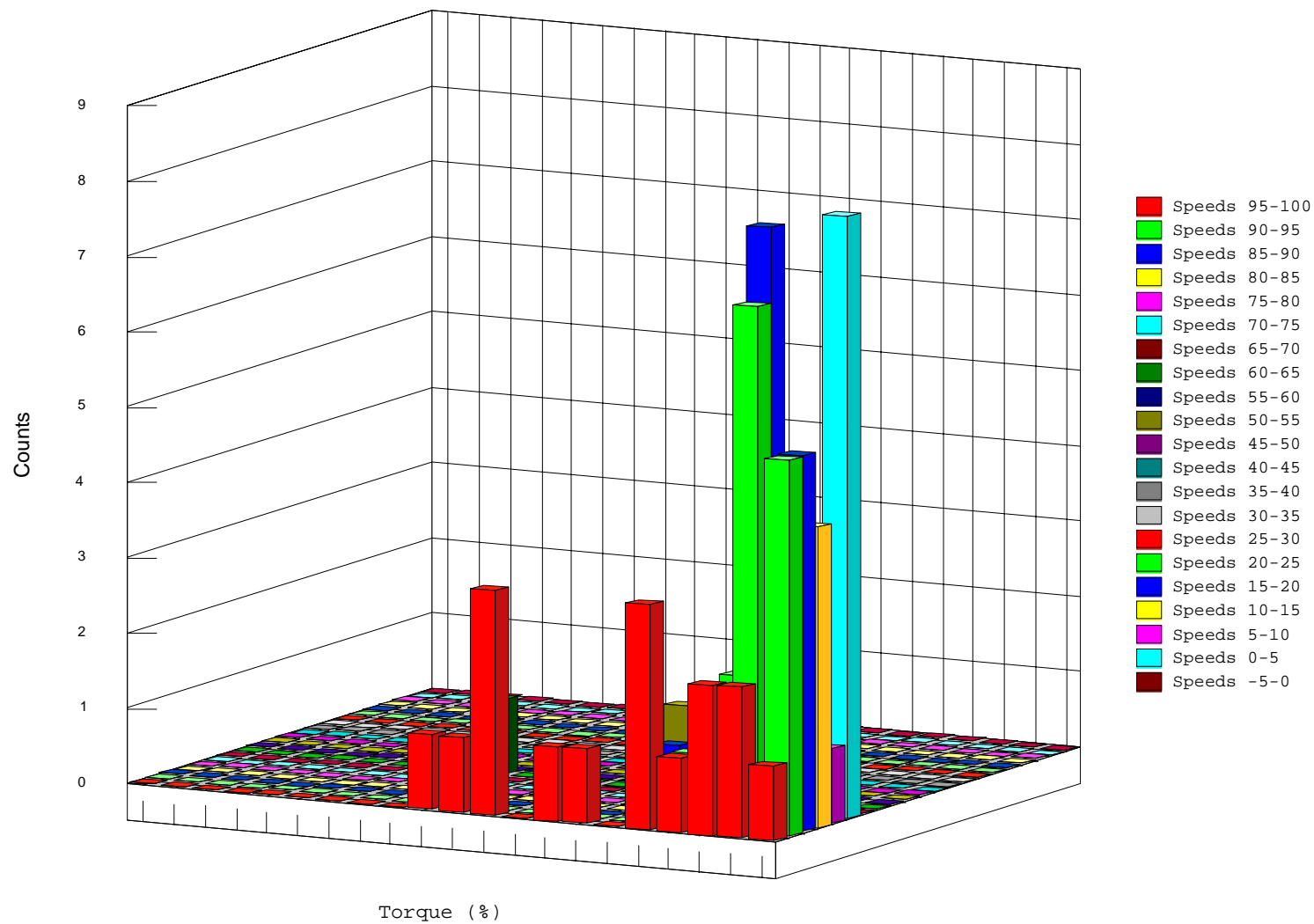




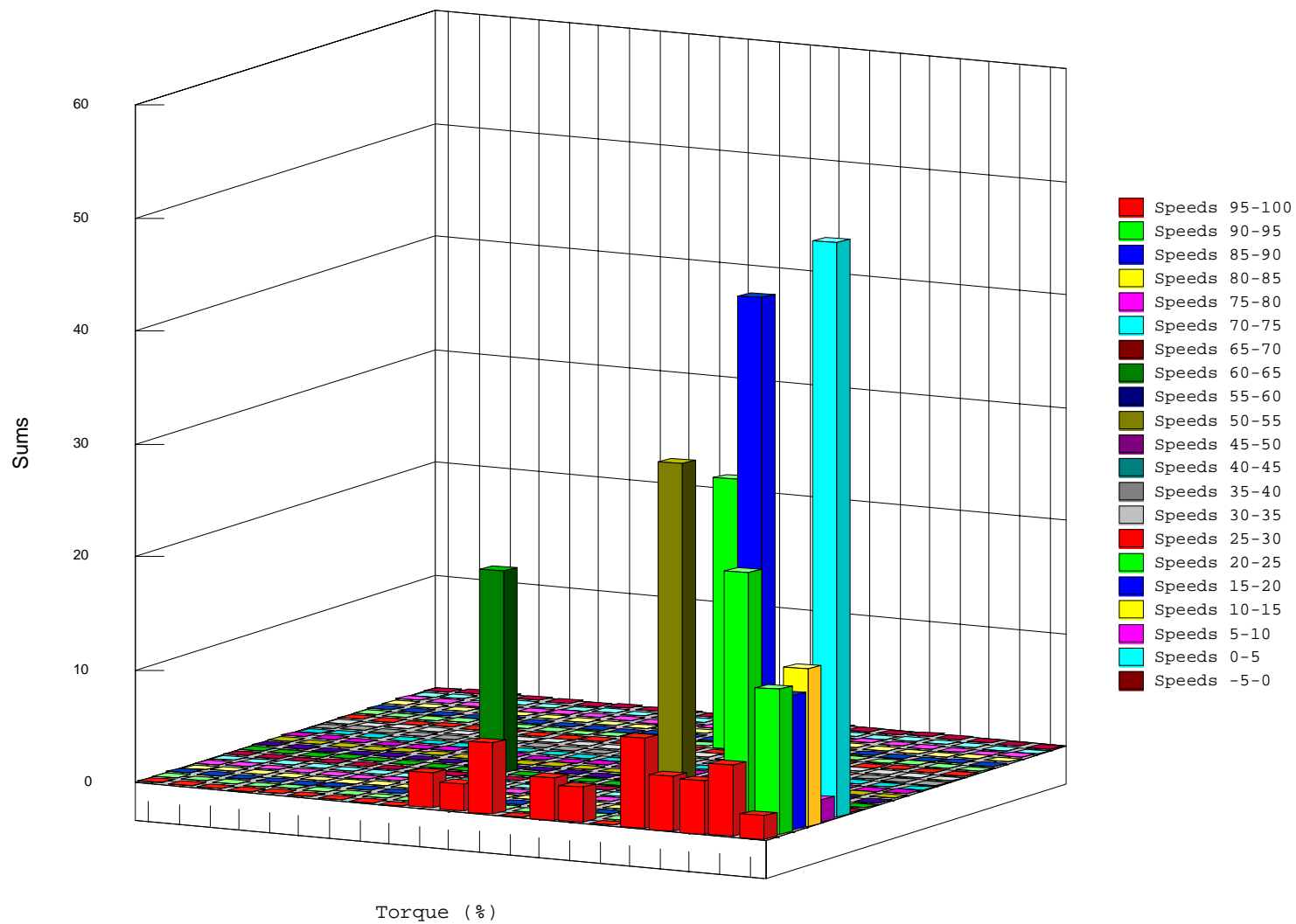
## Agtract--Mean Torque Changes



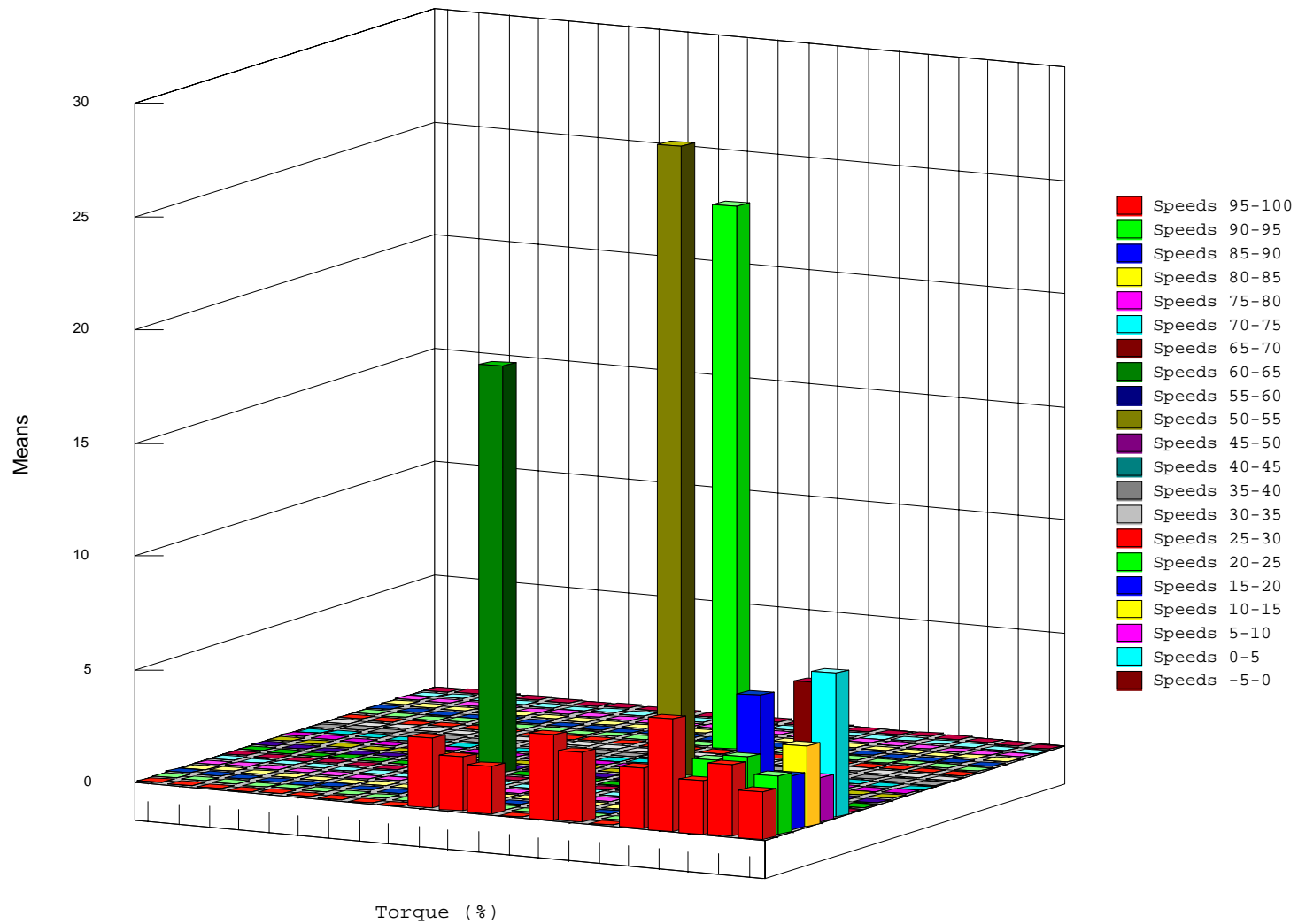
# Agtract--Speed Acceleration Counts



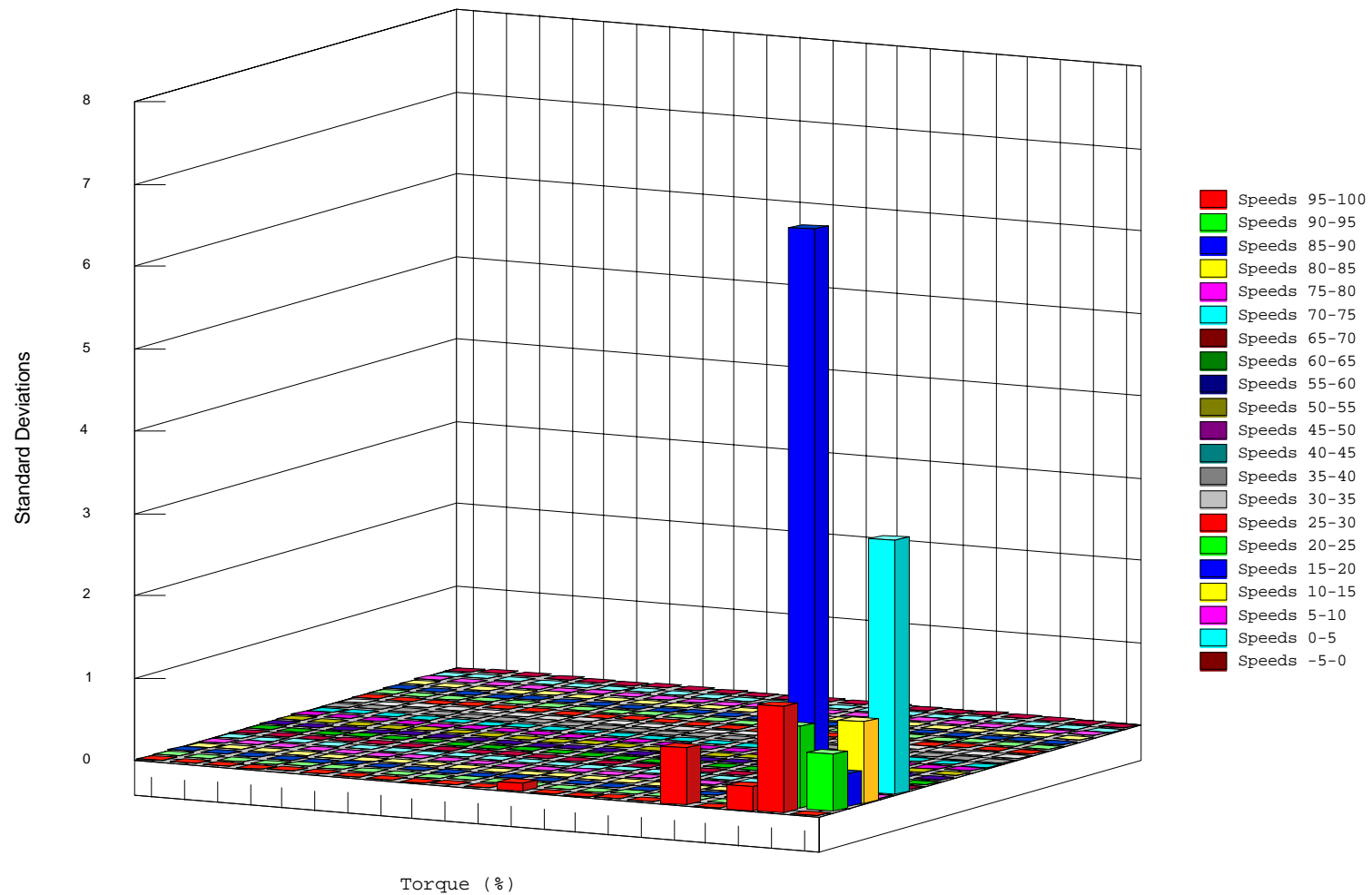
## Agtract--Speed Acceleration Sums



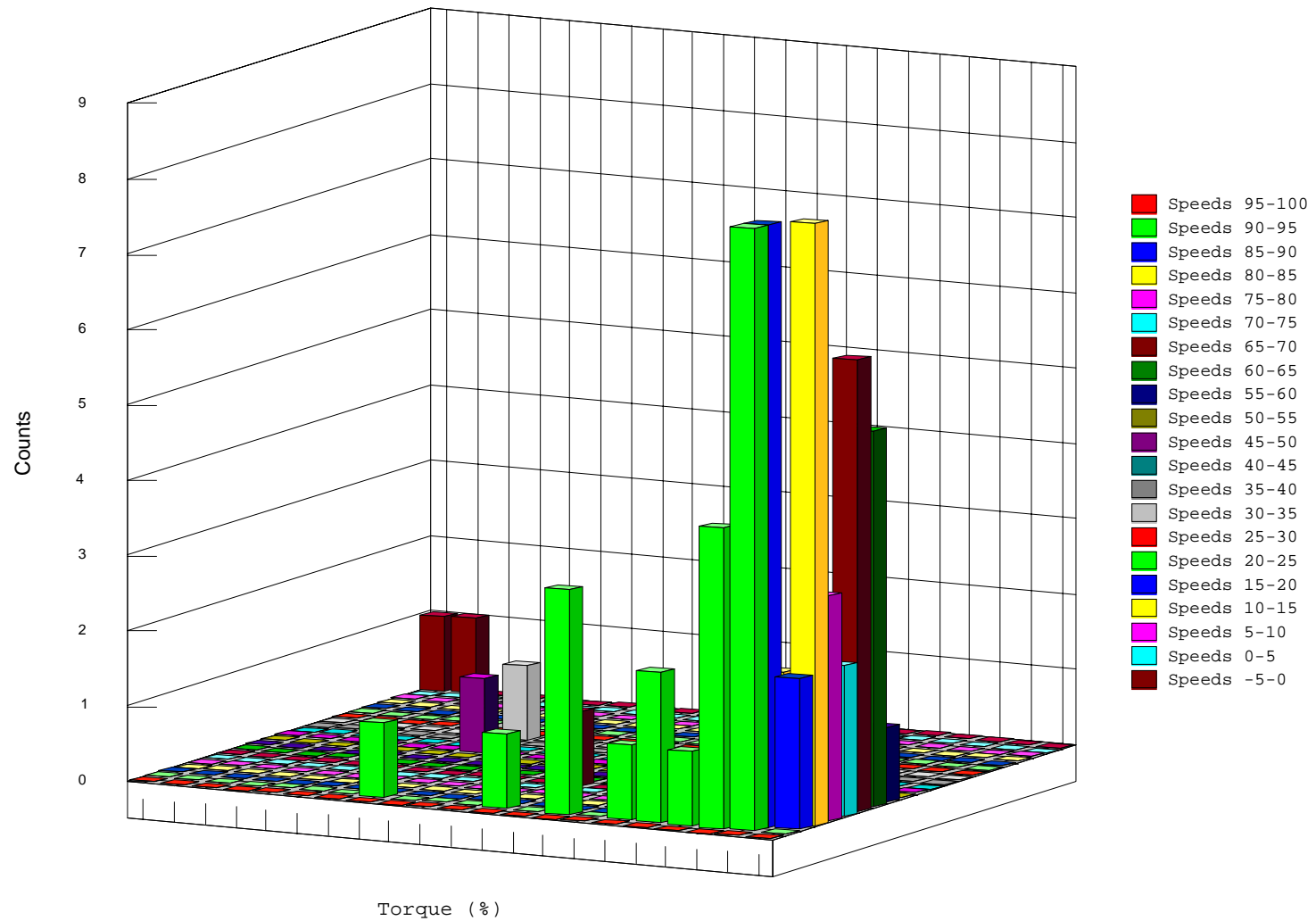
# Agtract--Speed Acceleration Means



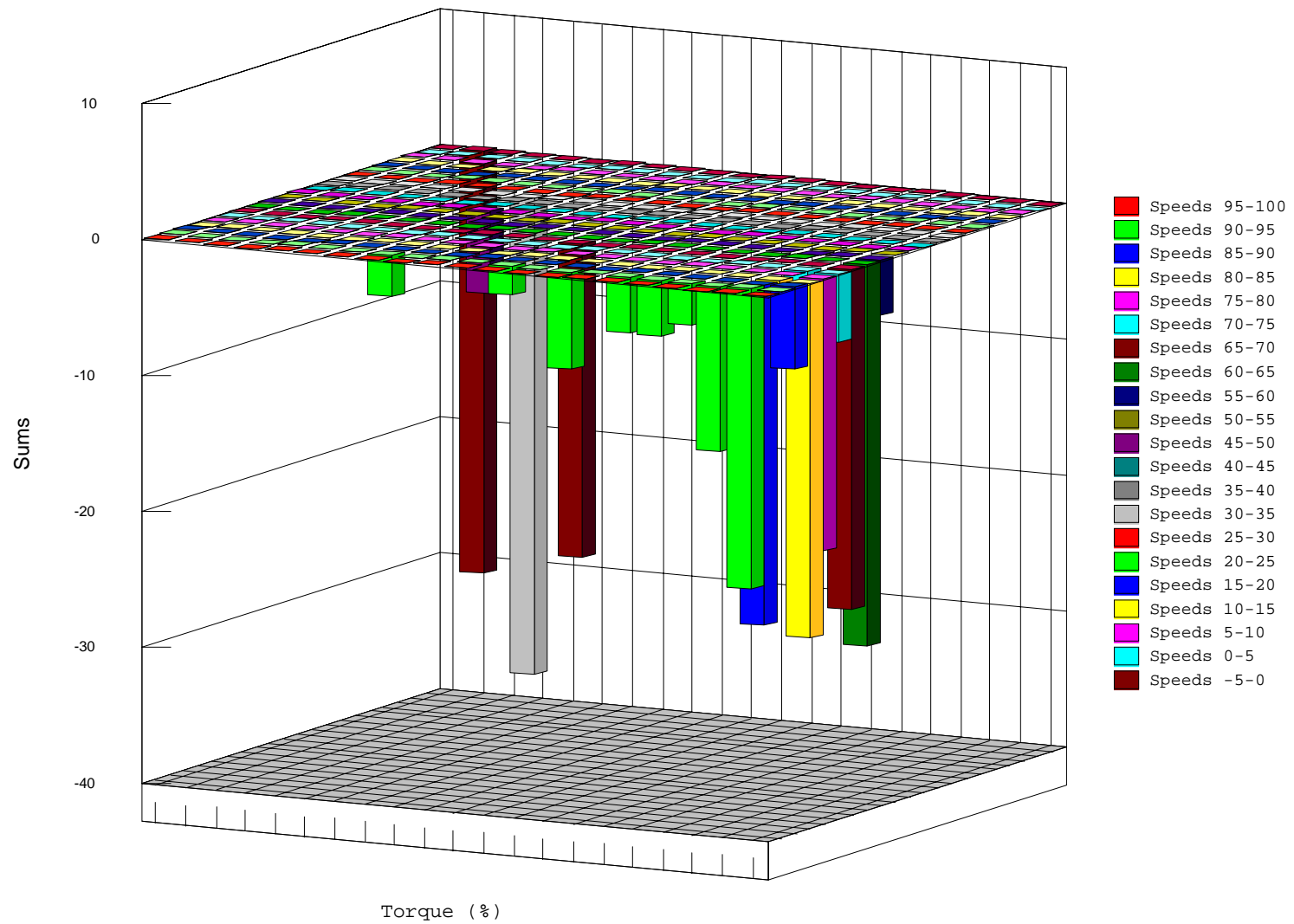
# Agtract--Speed Acceleration Std. Deviations



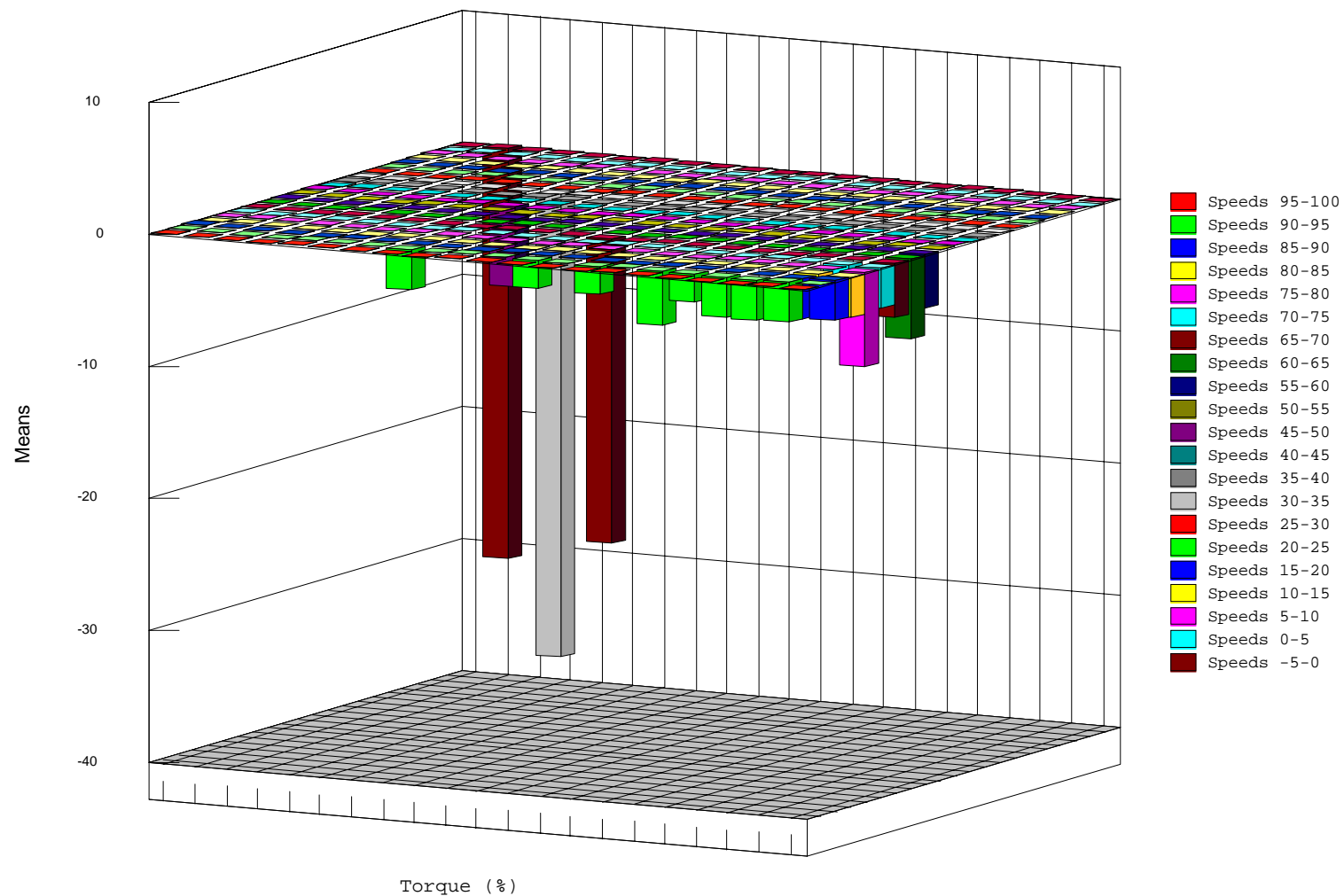
## Agtract--Speed Deceleration Counts



## Agtract--Speed Deceleration Sums

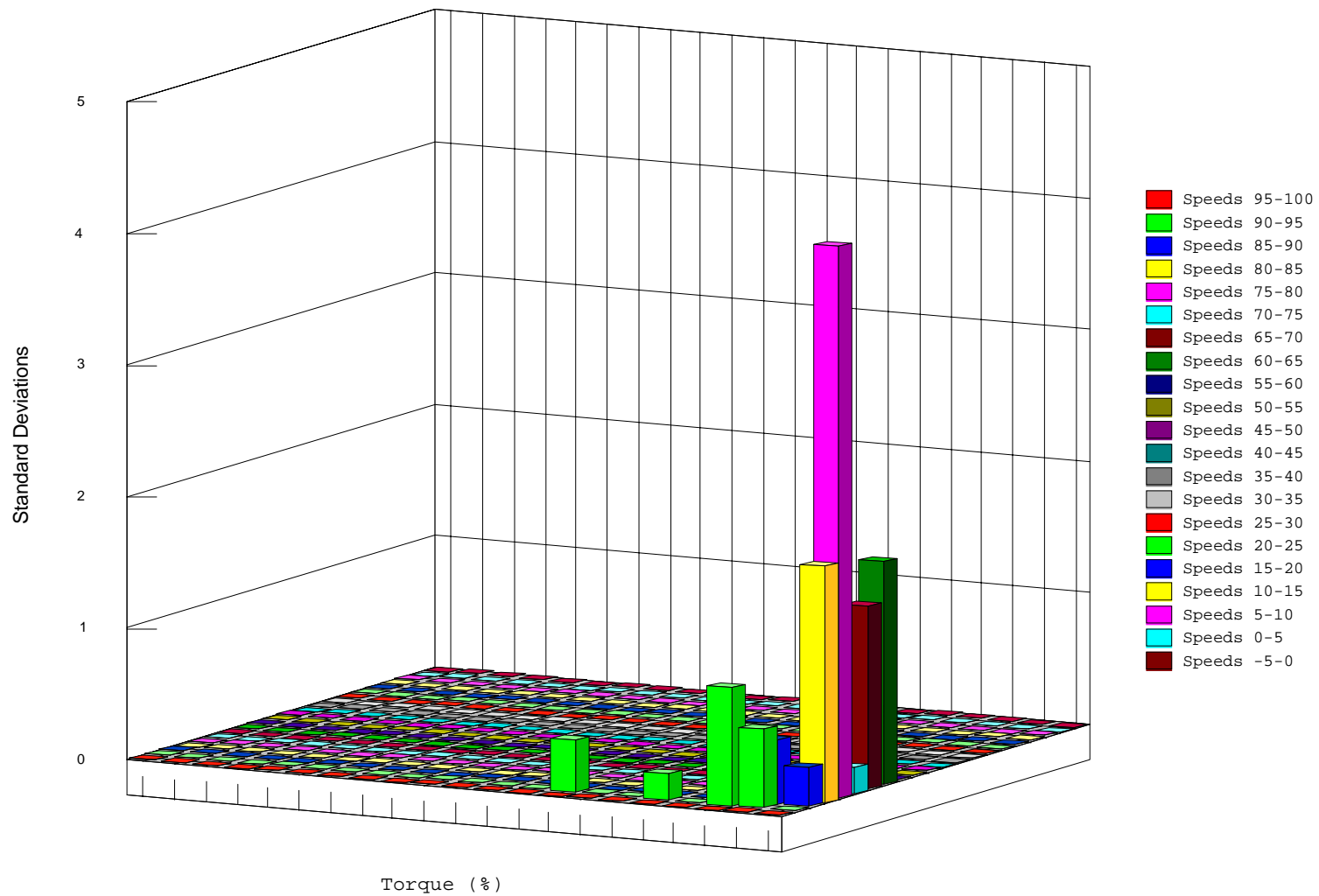


# Agtract--Speed Deceleration Means

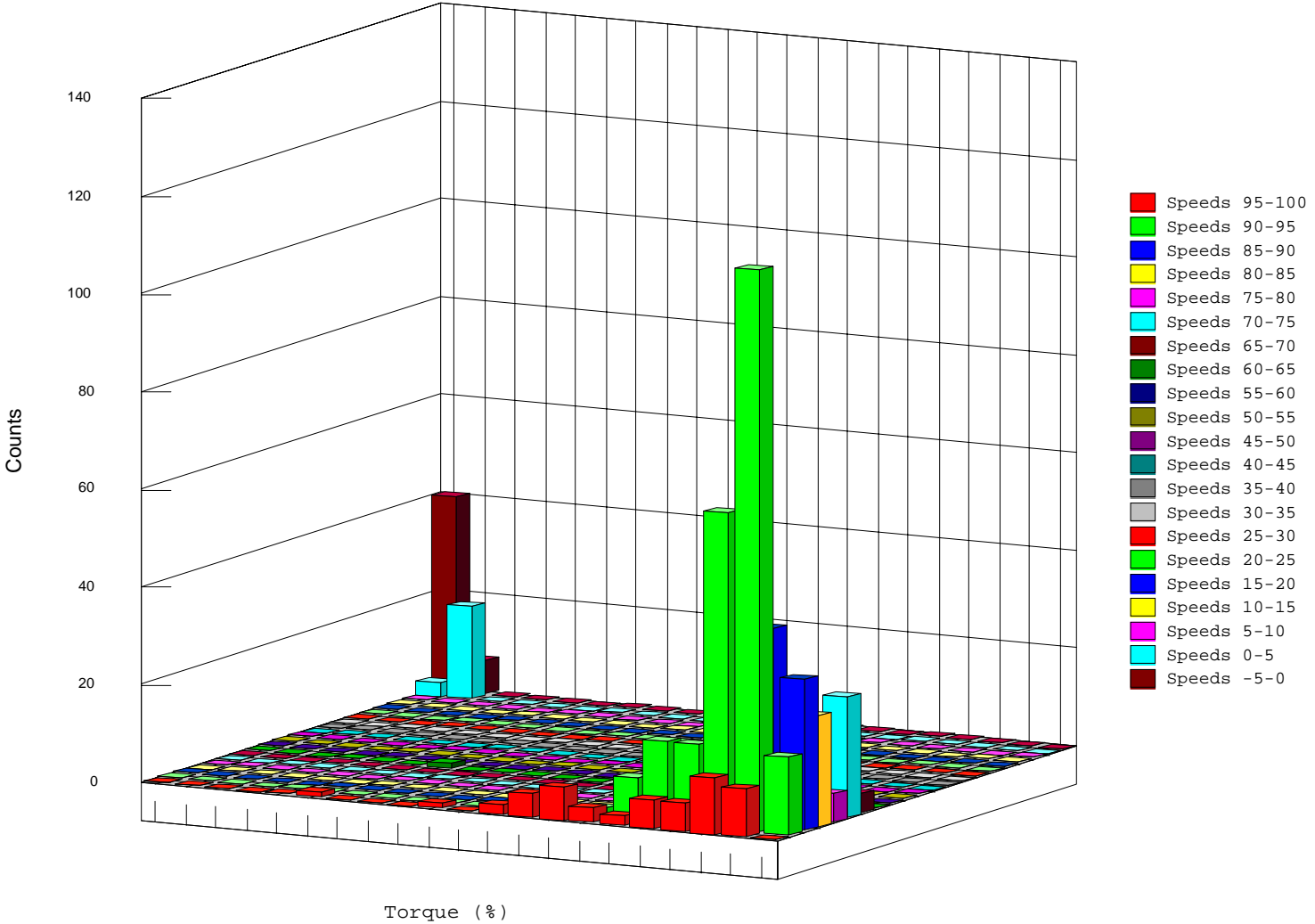




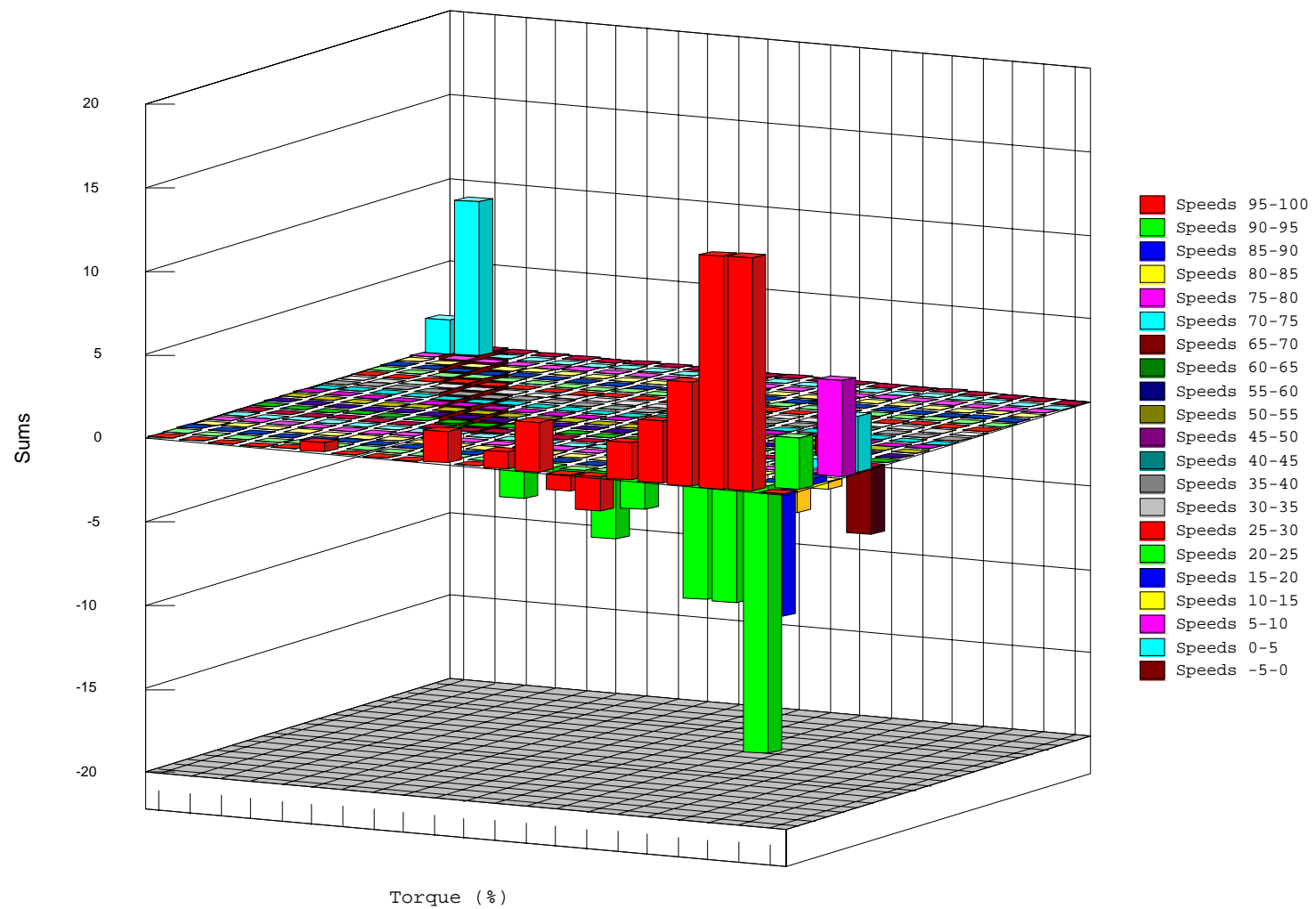
Agtract--Speed Deceleration Std. Deviations	
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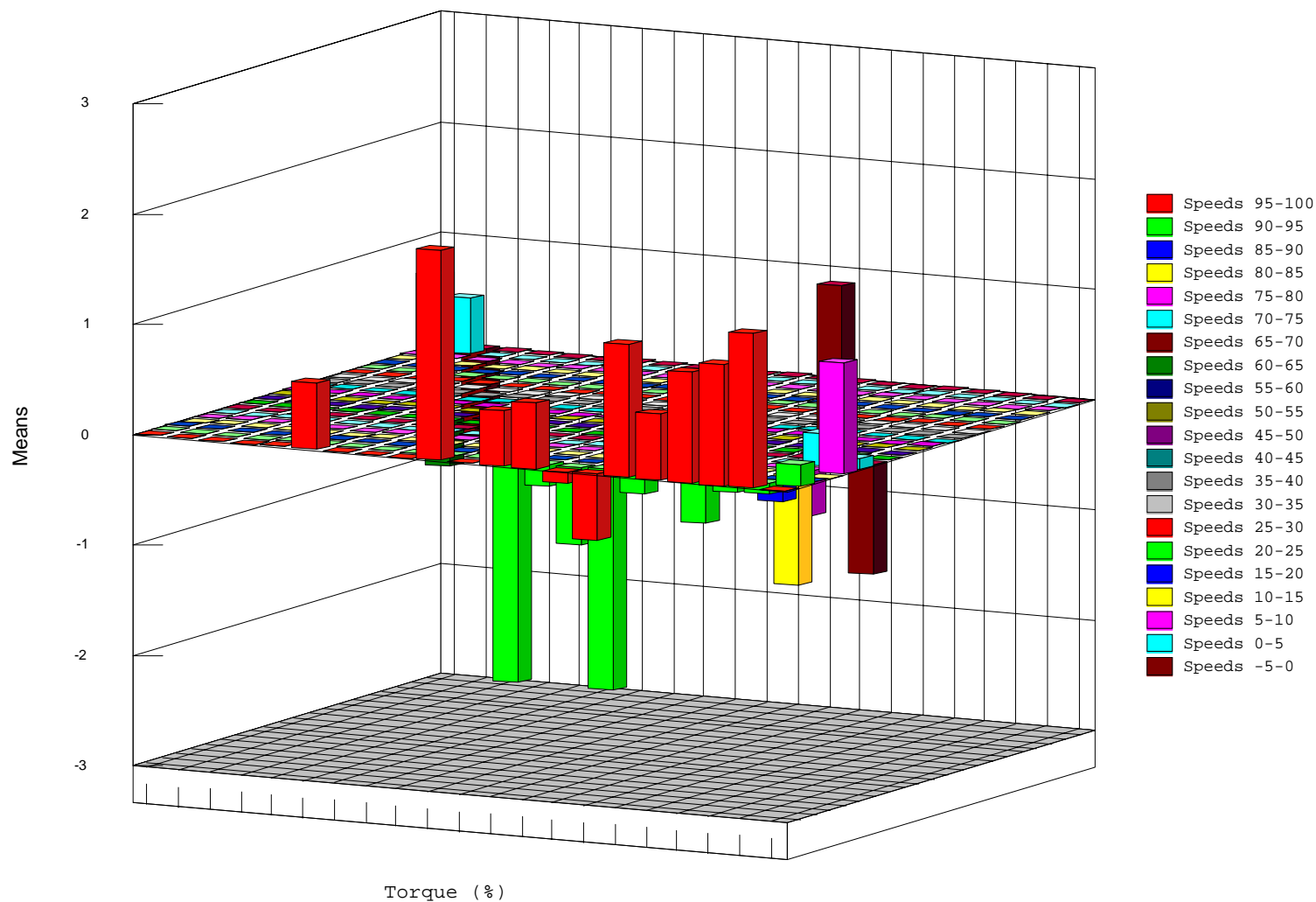
## Agtract--Speed Steady State Counts



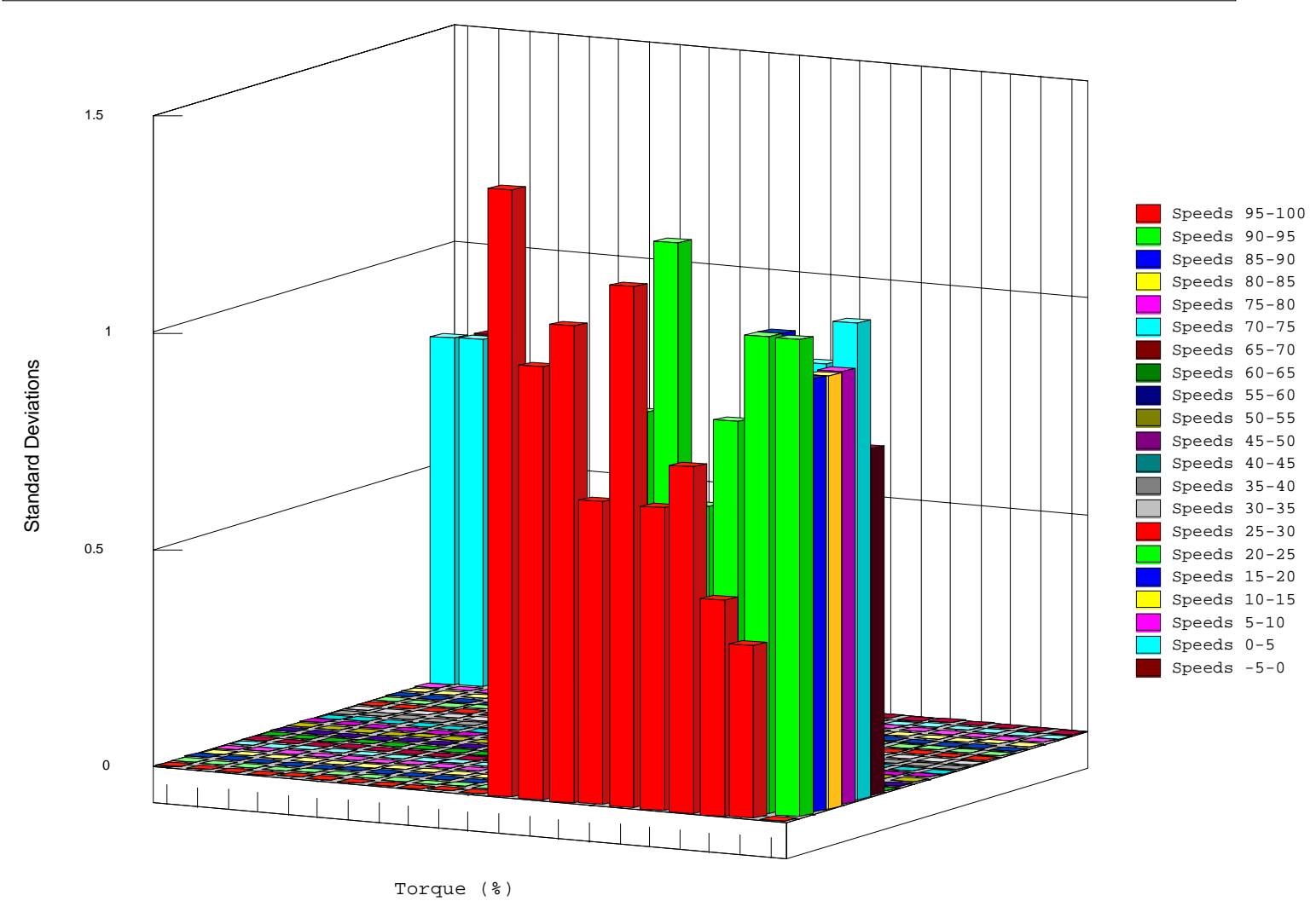
## Agtract--Speed Steady State Sums



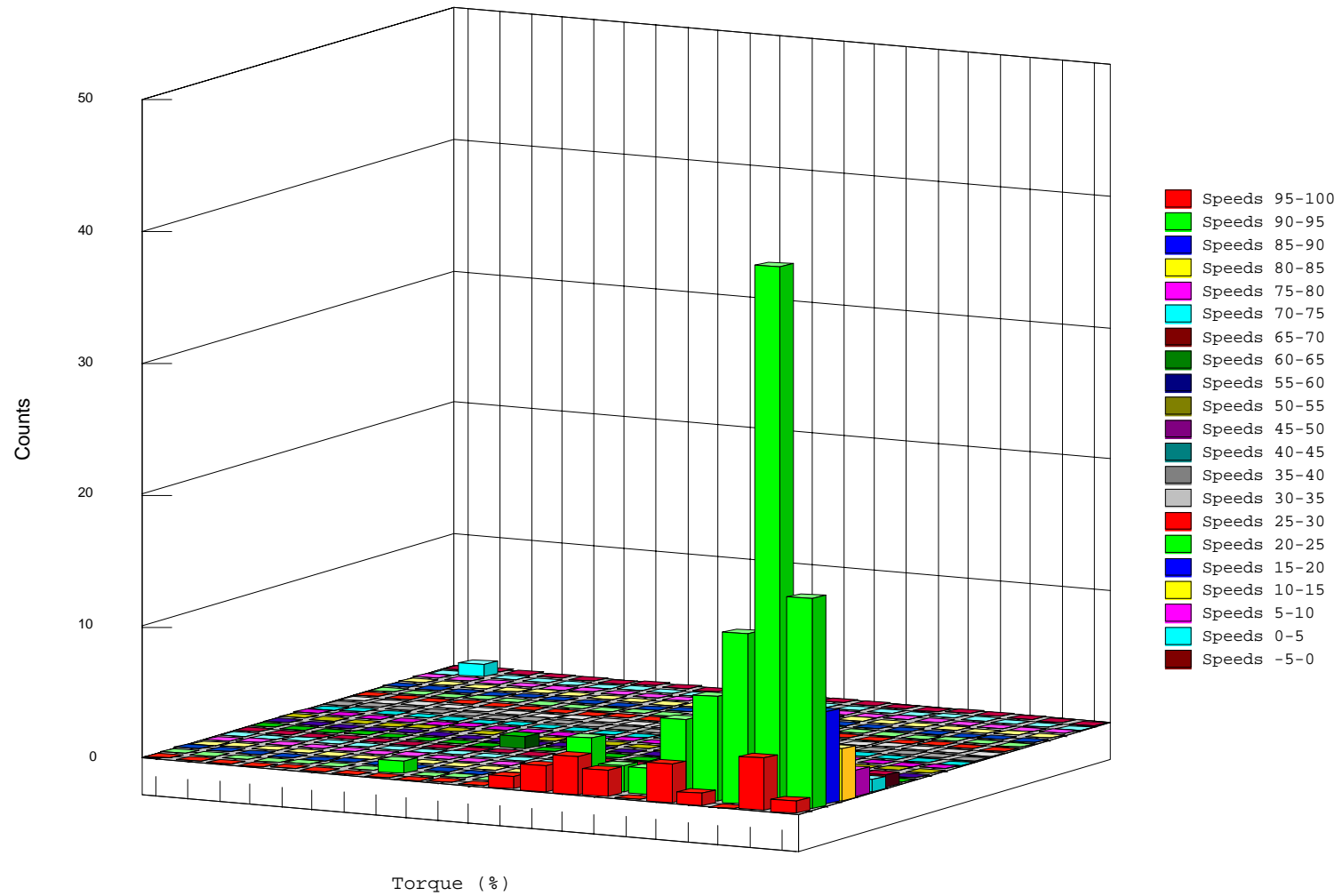
# Atract--Speed Steady State Means



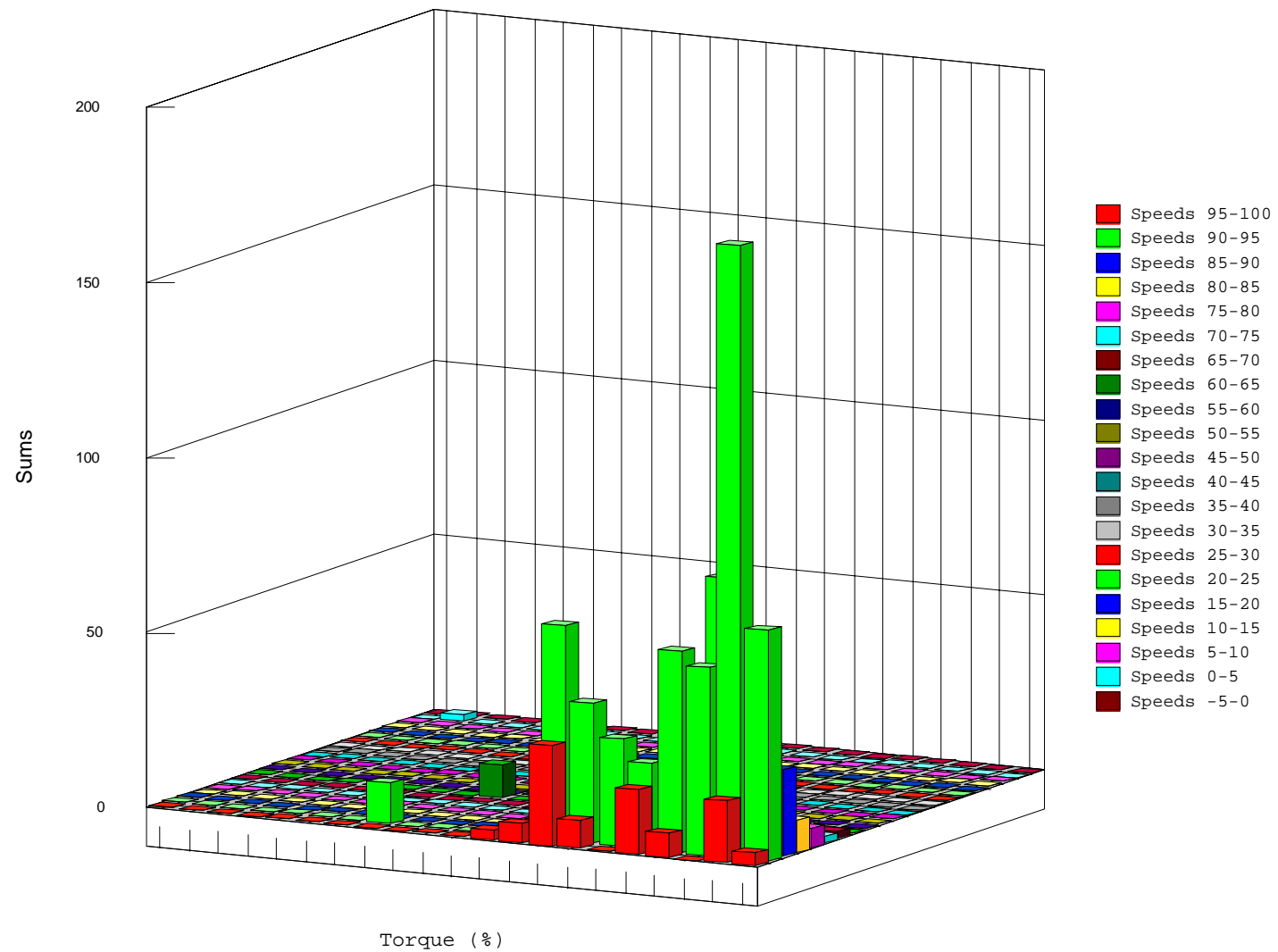
Agtract--Speed Steady State Std. Deviations	
Agtract	0.0000
Speed	0.0000



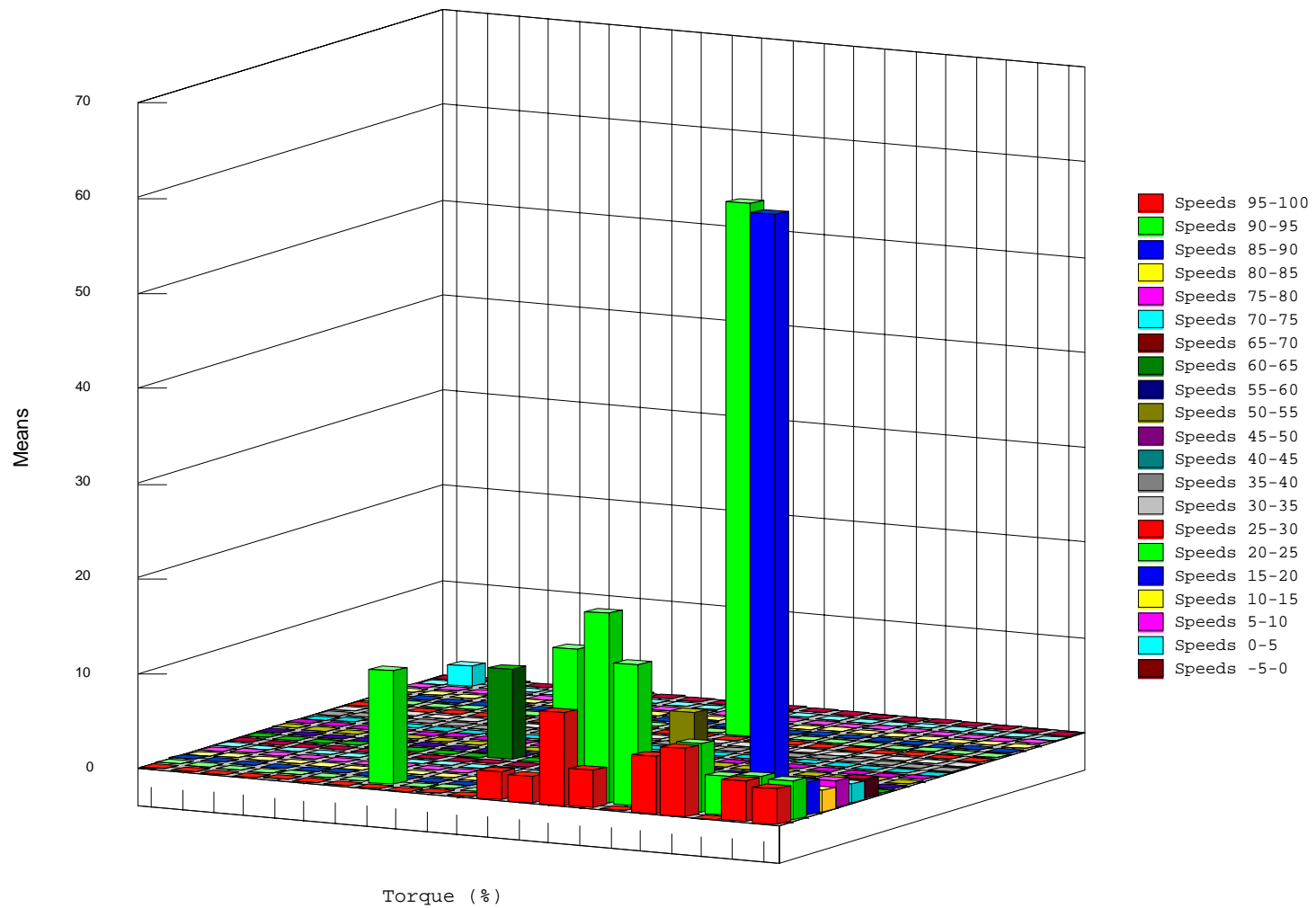
## Agtract--Torque Acceleration Counts



## Agtract--Torque Acceleration Sums

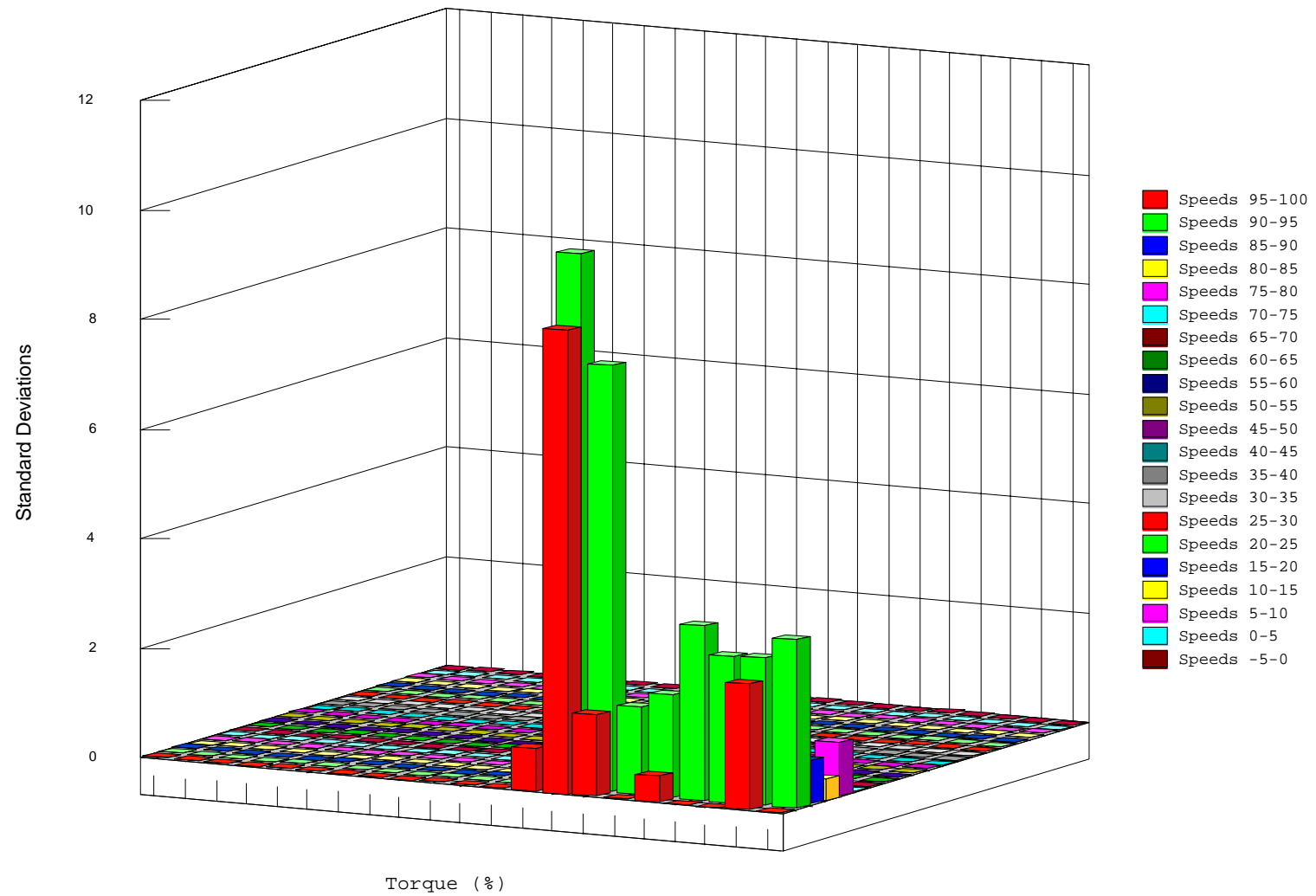


## Agract--Torque Acceleration Means

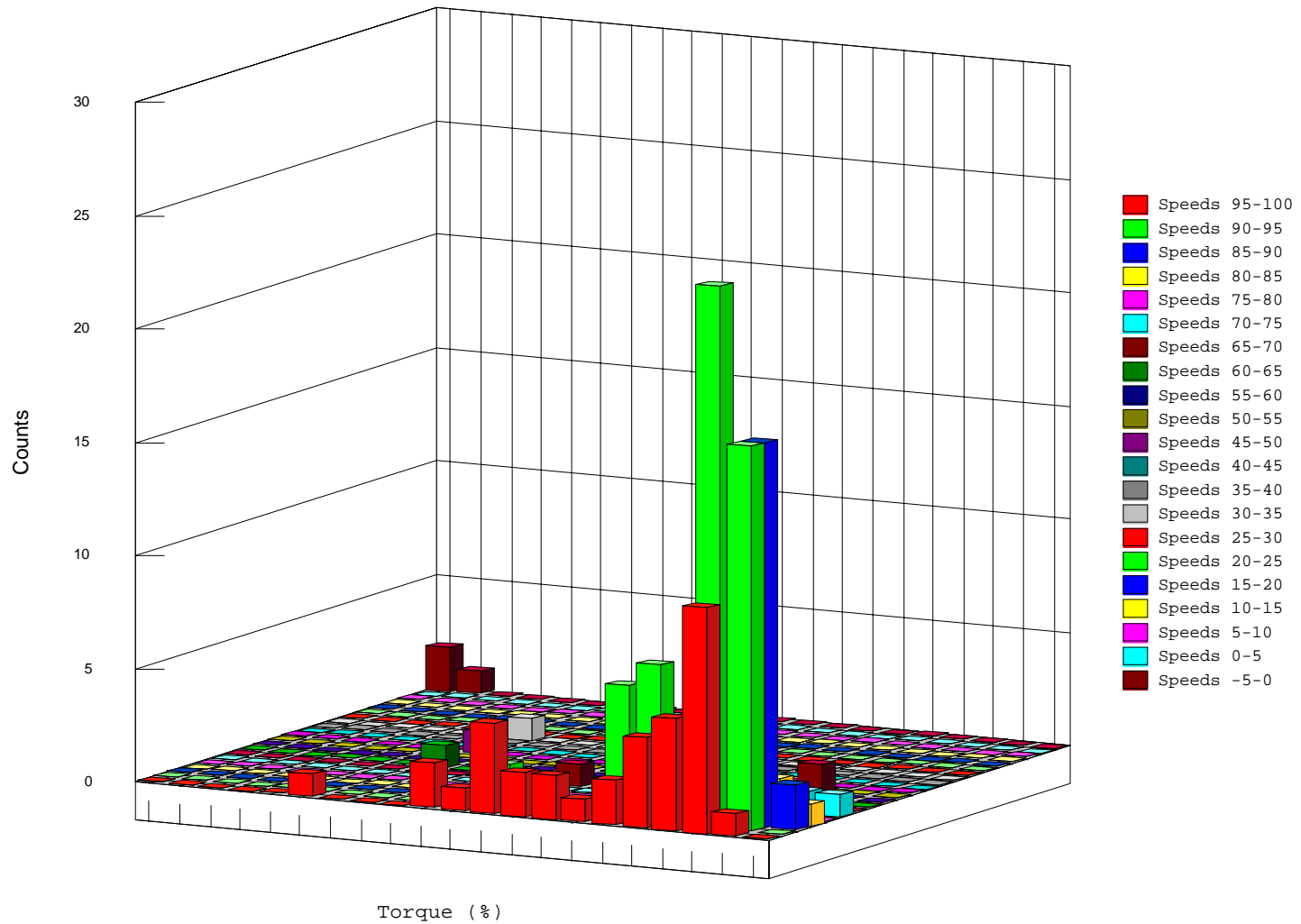




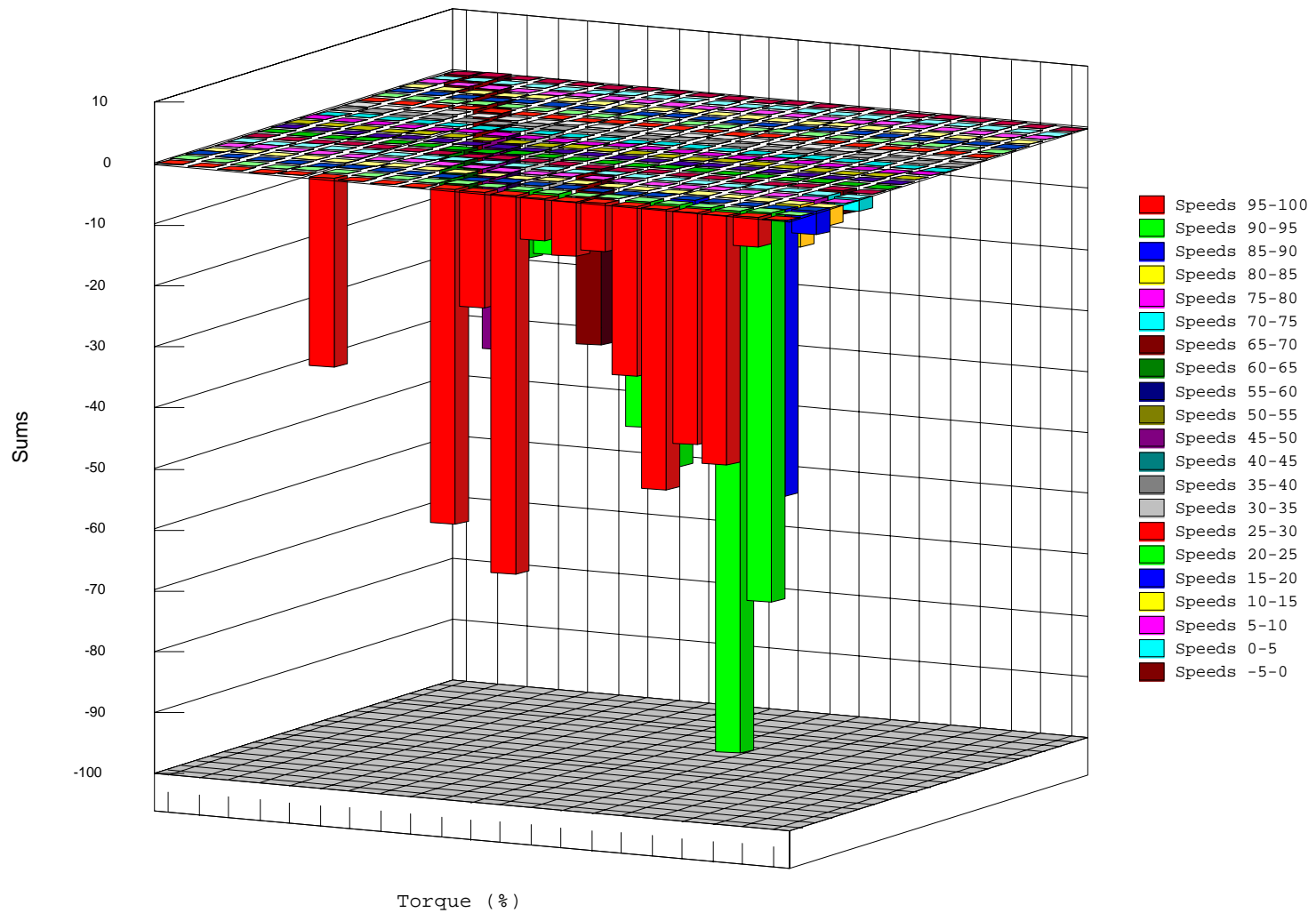
# Agtract--Torque Acceleration Std. Deviations



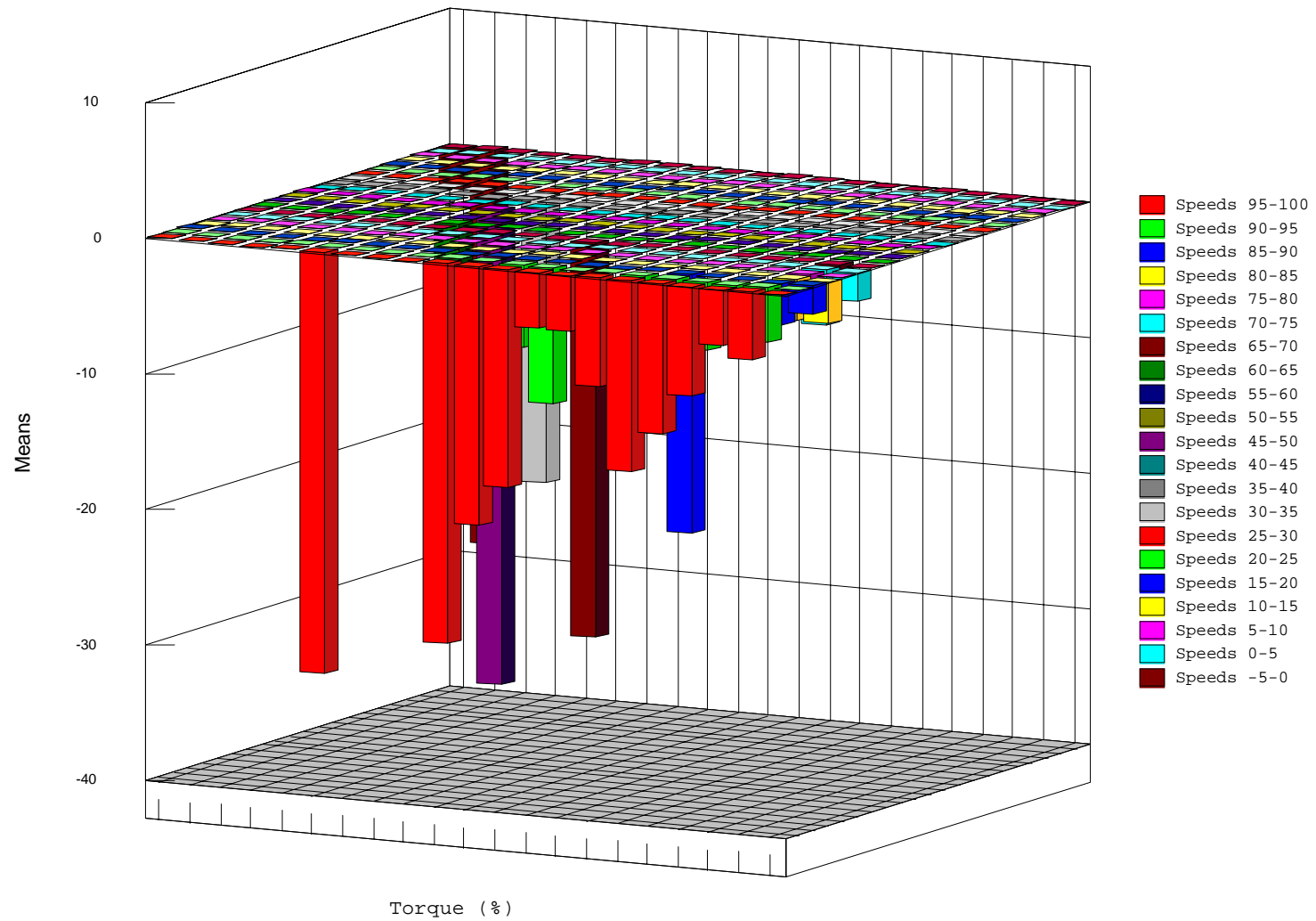
## Agtract--Torque Deceleration Counts

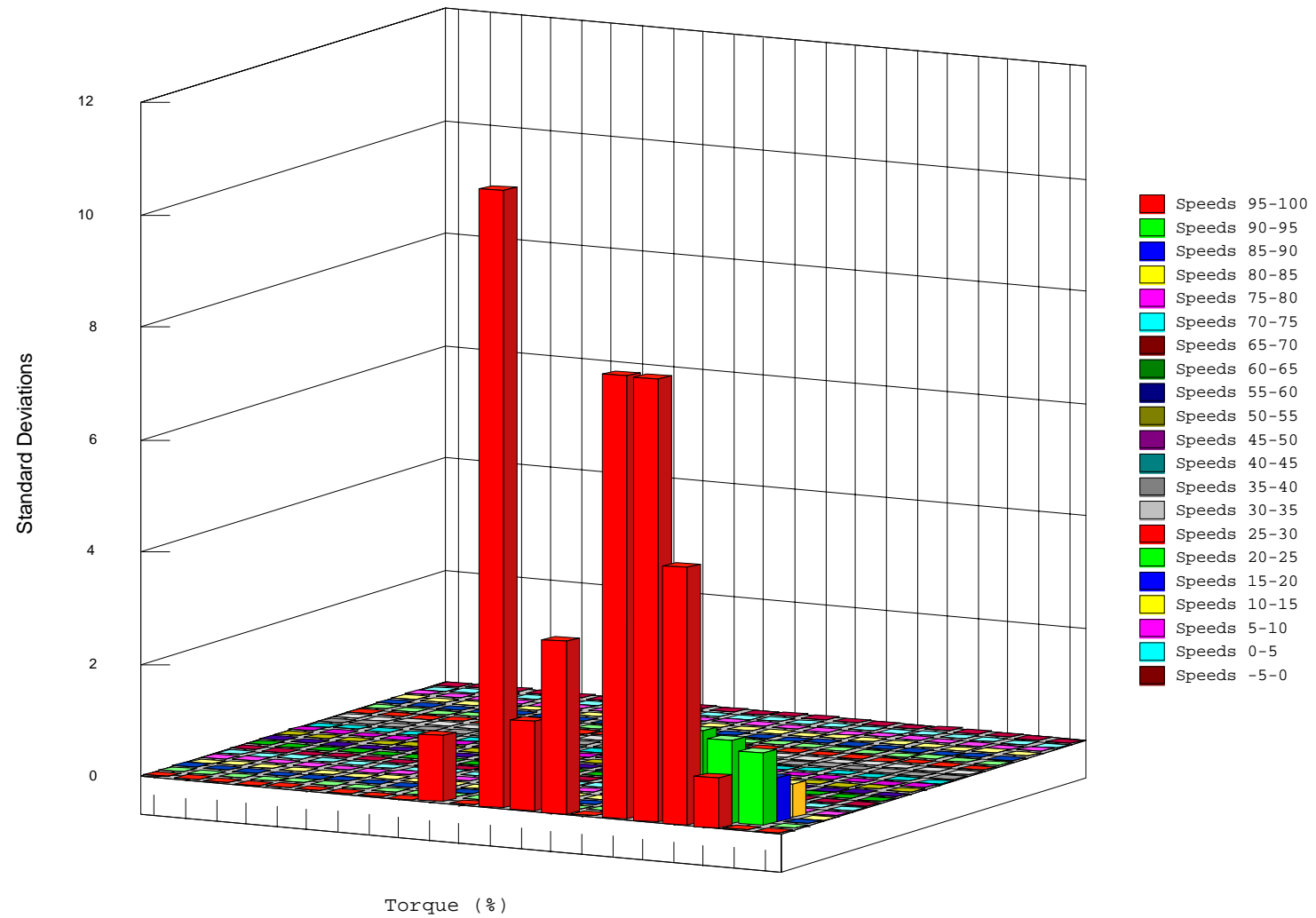


## Agtract--Torque Deceleration Sums

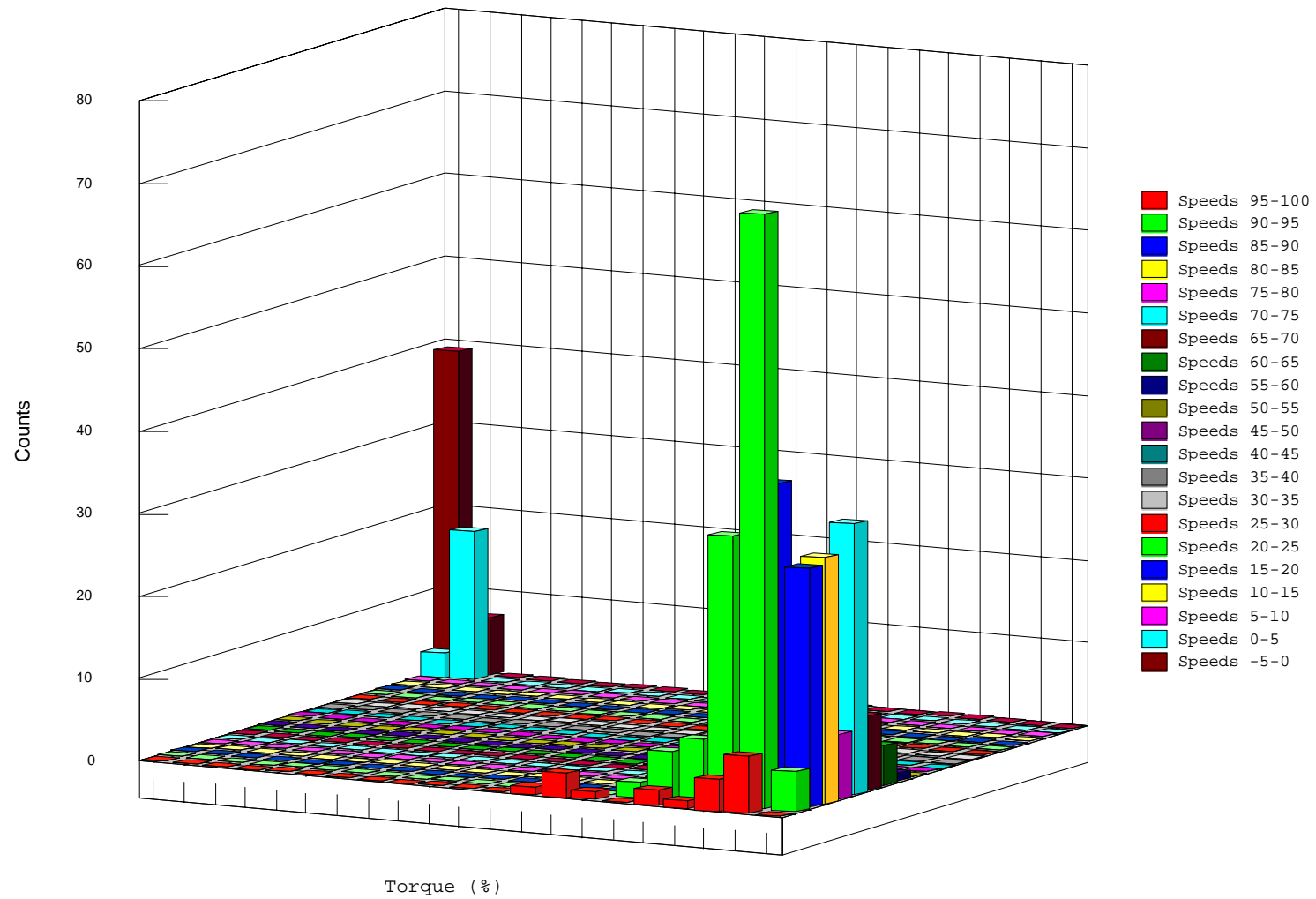


## Agtract--Torque Deceleration Means

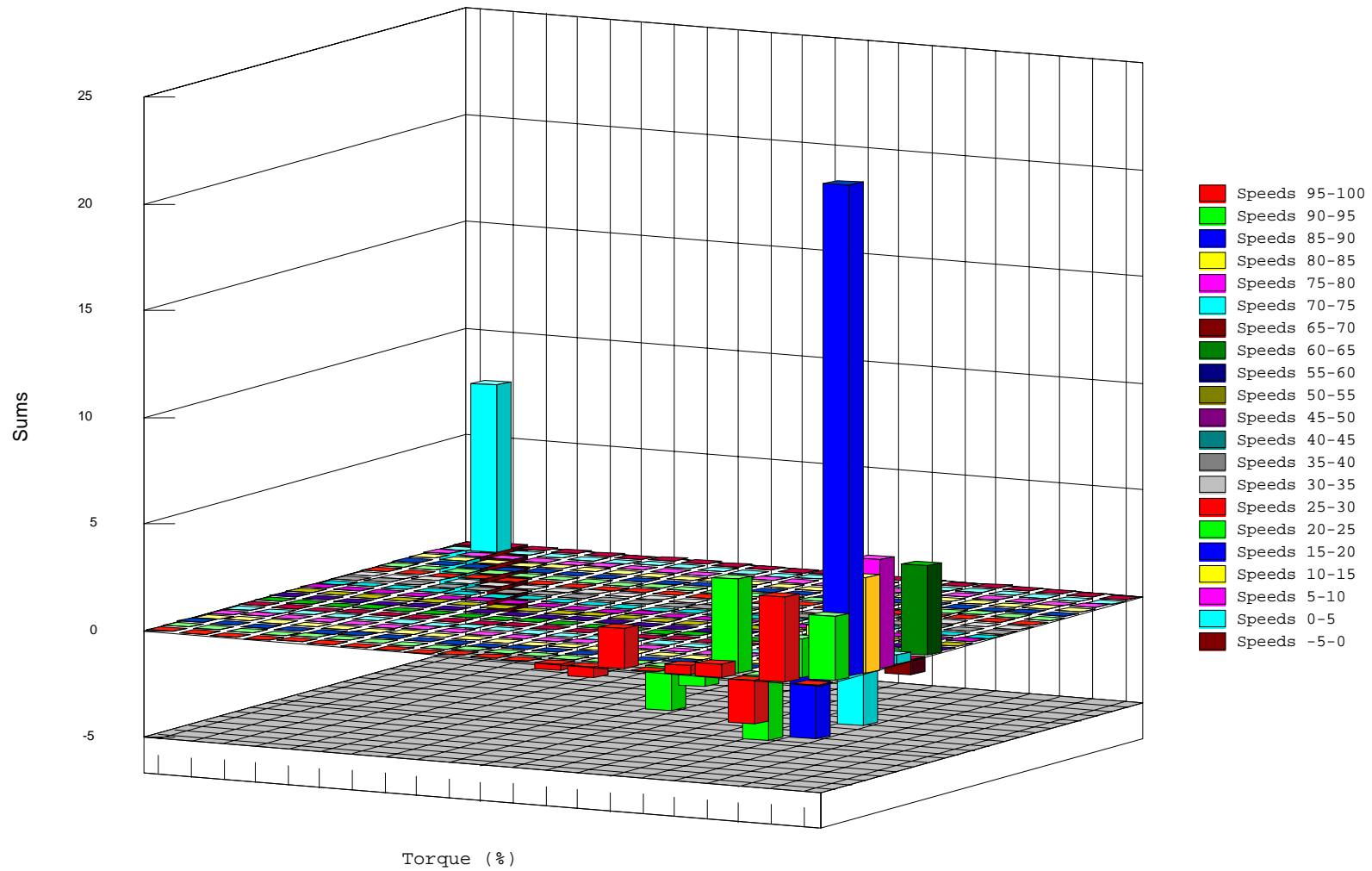


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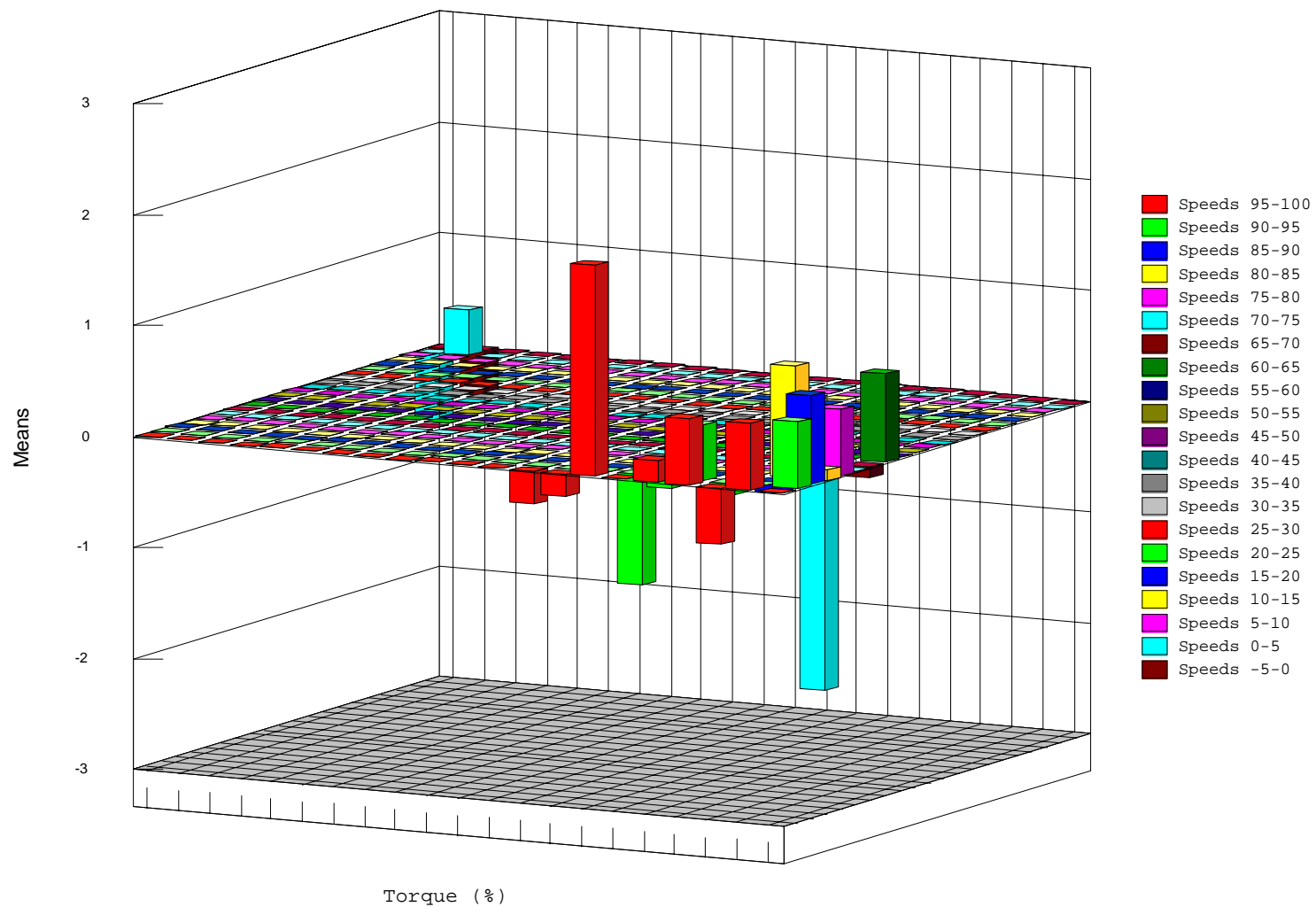
## Agtract--Torque Steady State Counts



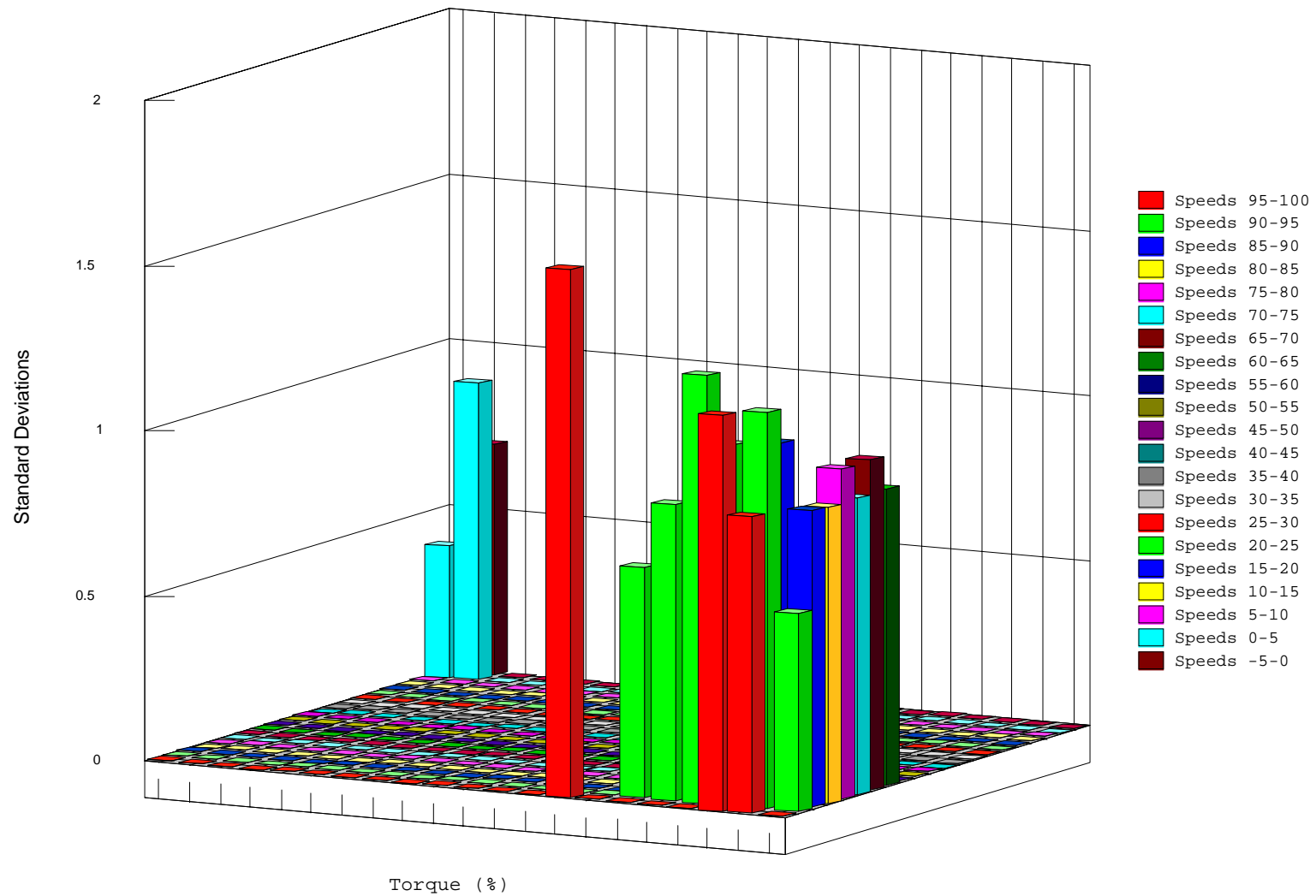
## Agtract--Torque Steady State Sums



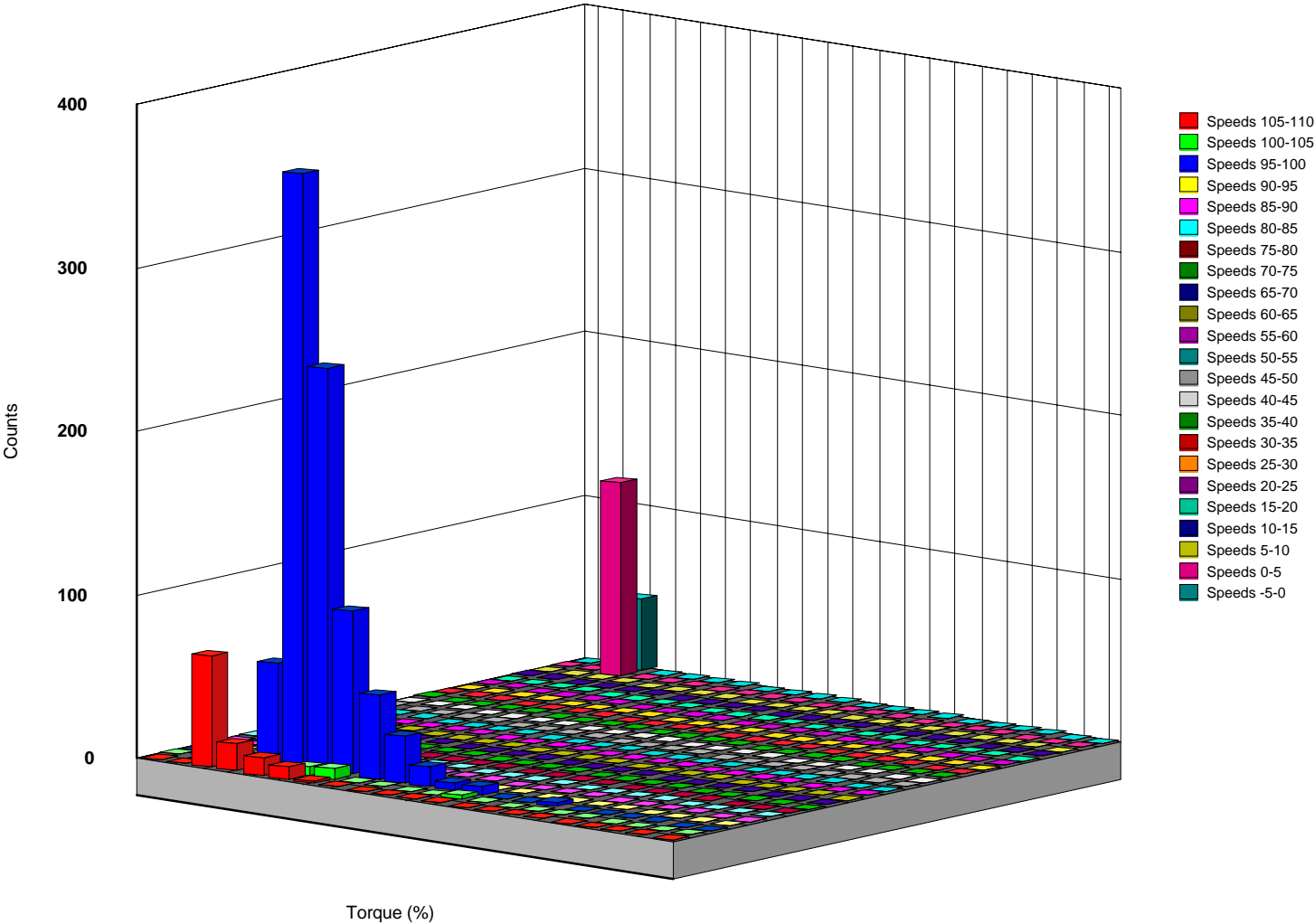
## Agtract--Torque Steady State Means



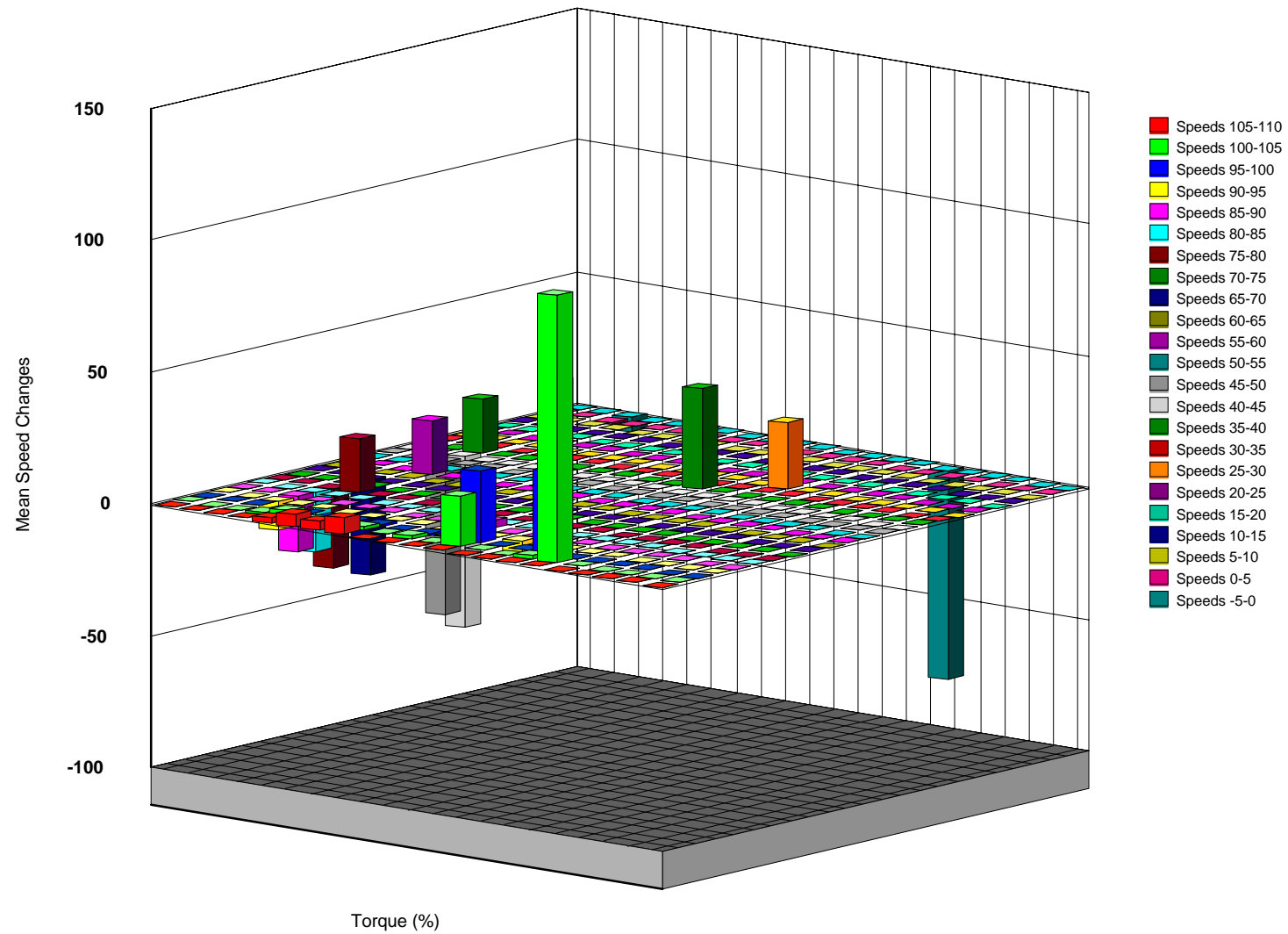


[illegible]

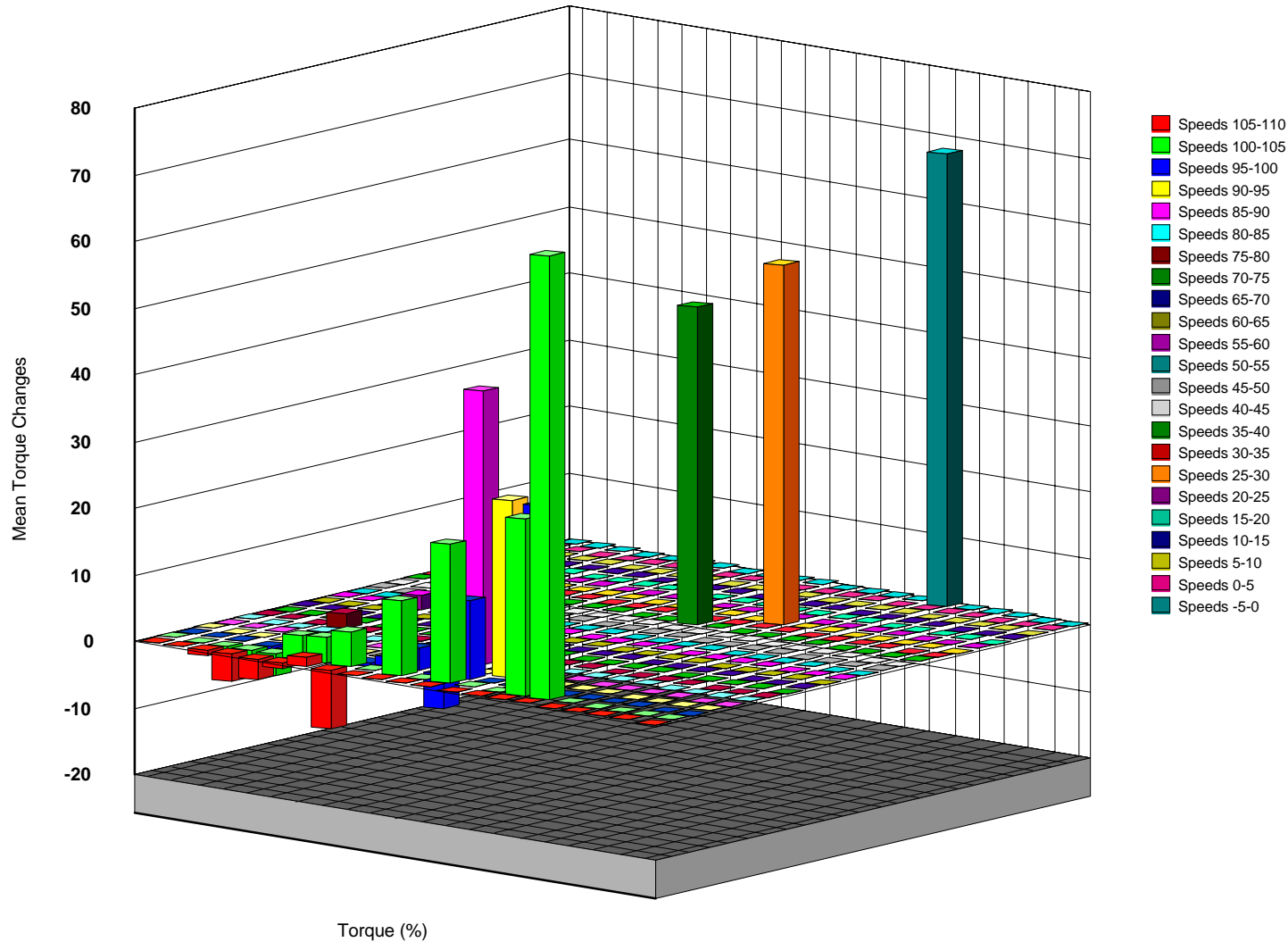
# WELDER TYPICAL 1--Counts



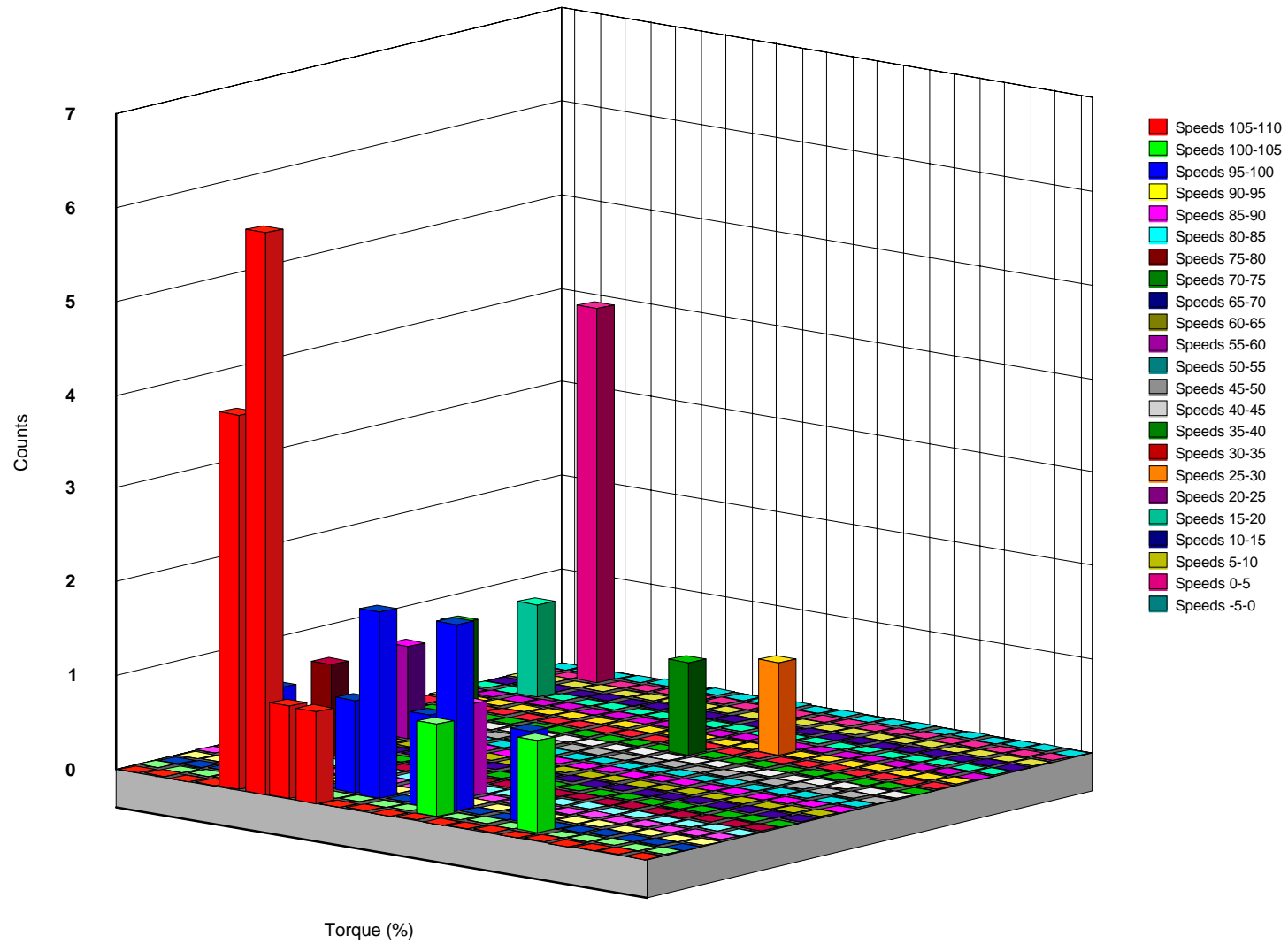
## WELDER TYPICAL 1--Mean Speed Changes



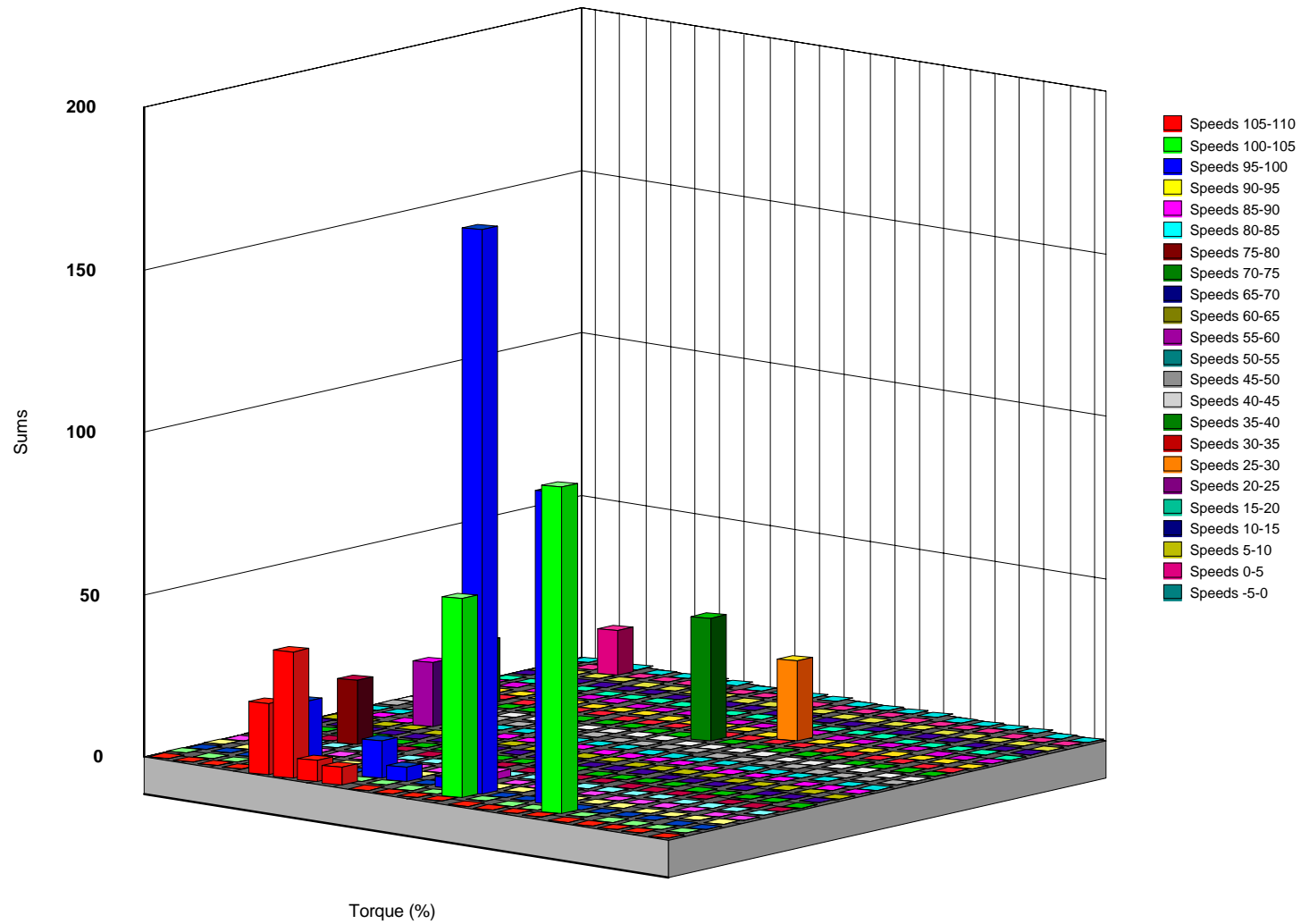
WELDER TYPICAL 1--Mean Torque Changes



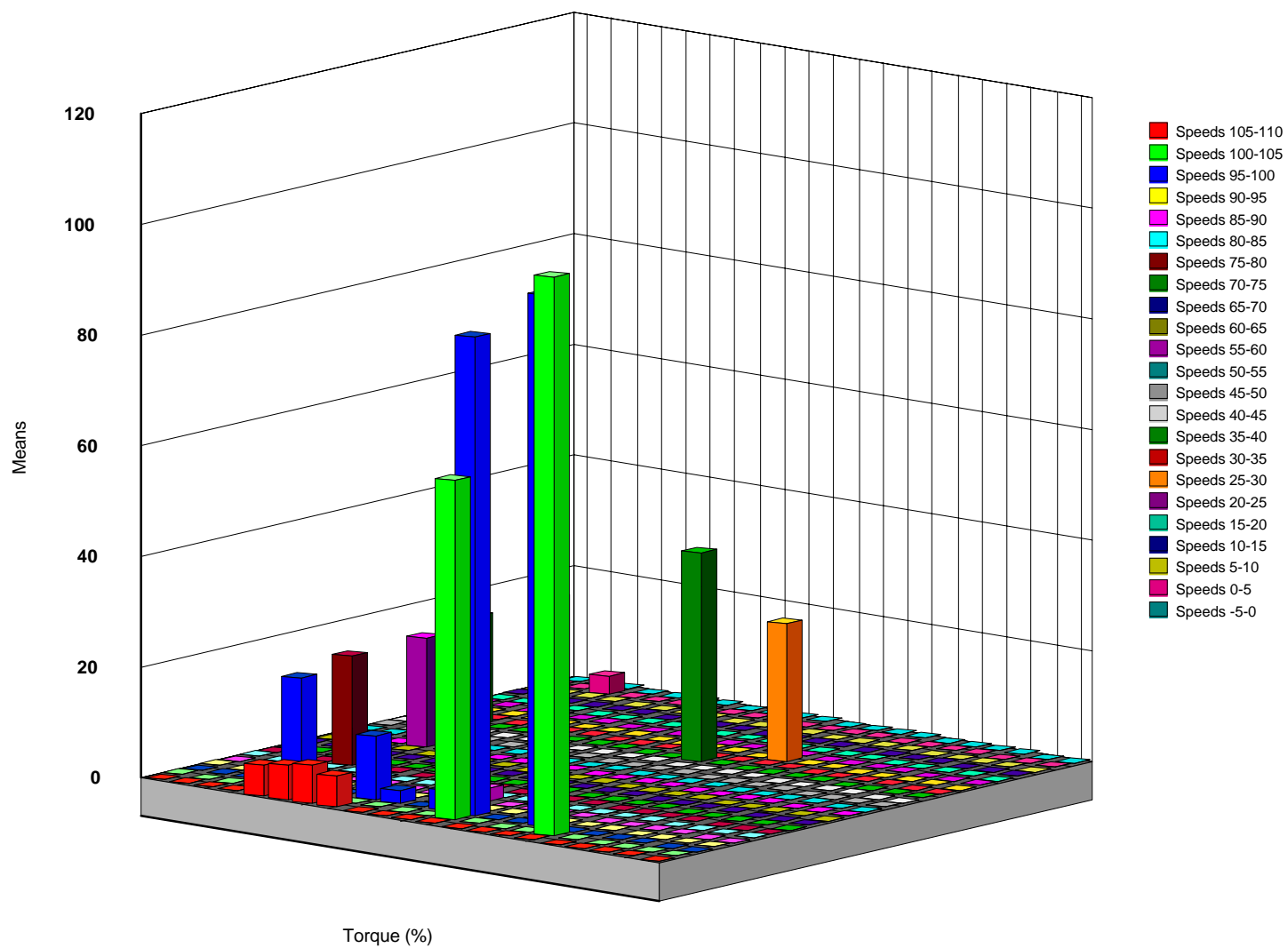
## WELDER TYPICAL 1--Speed Acceleration Counts



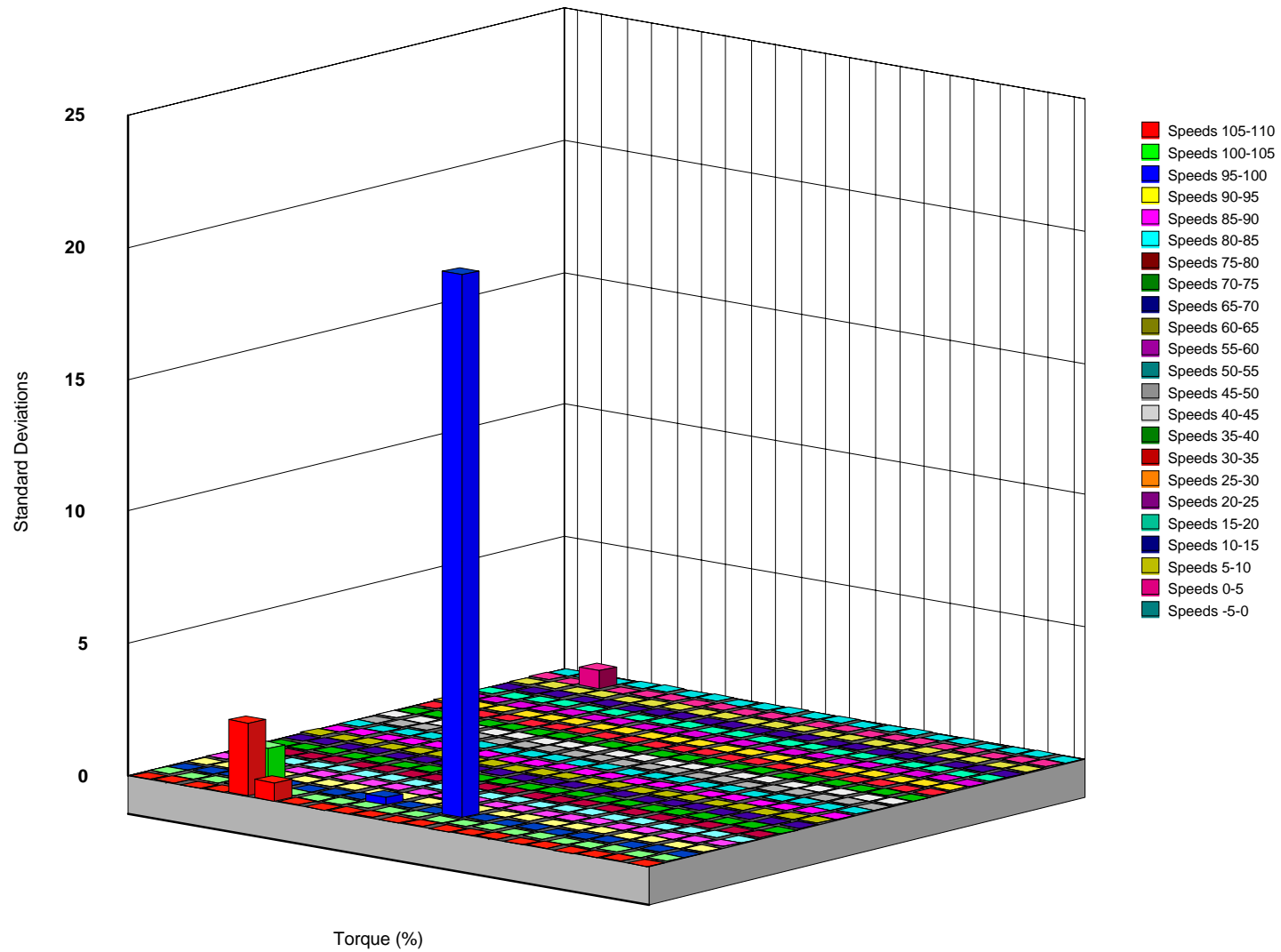
## WELDER TYPICAL 1--Speed Acceleration Sums



## WELDER TYPICAL 1--Speed Acceleration Means

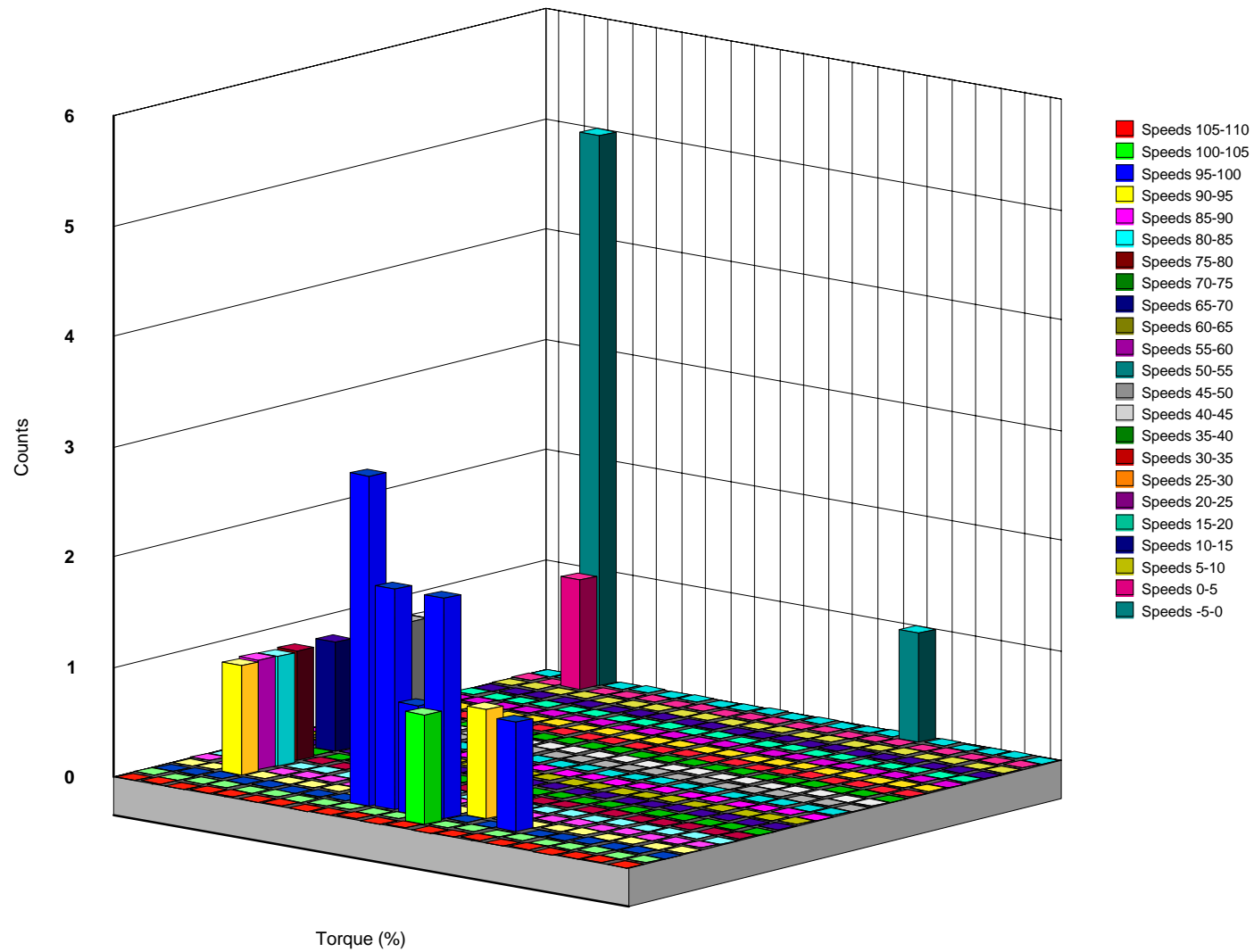


## WELDER TYPICAL 1--Speed Acceleration Standard Deviations

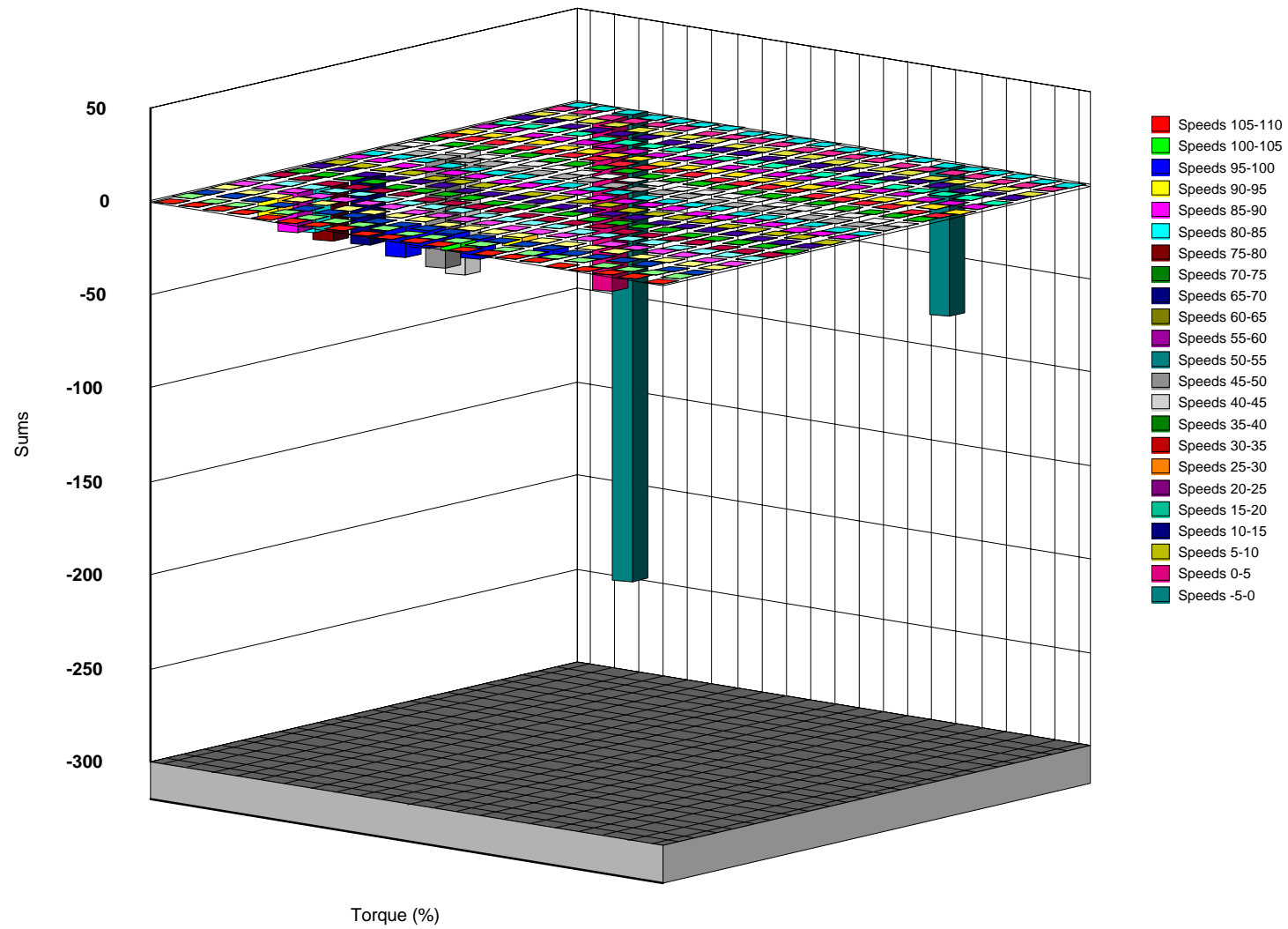




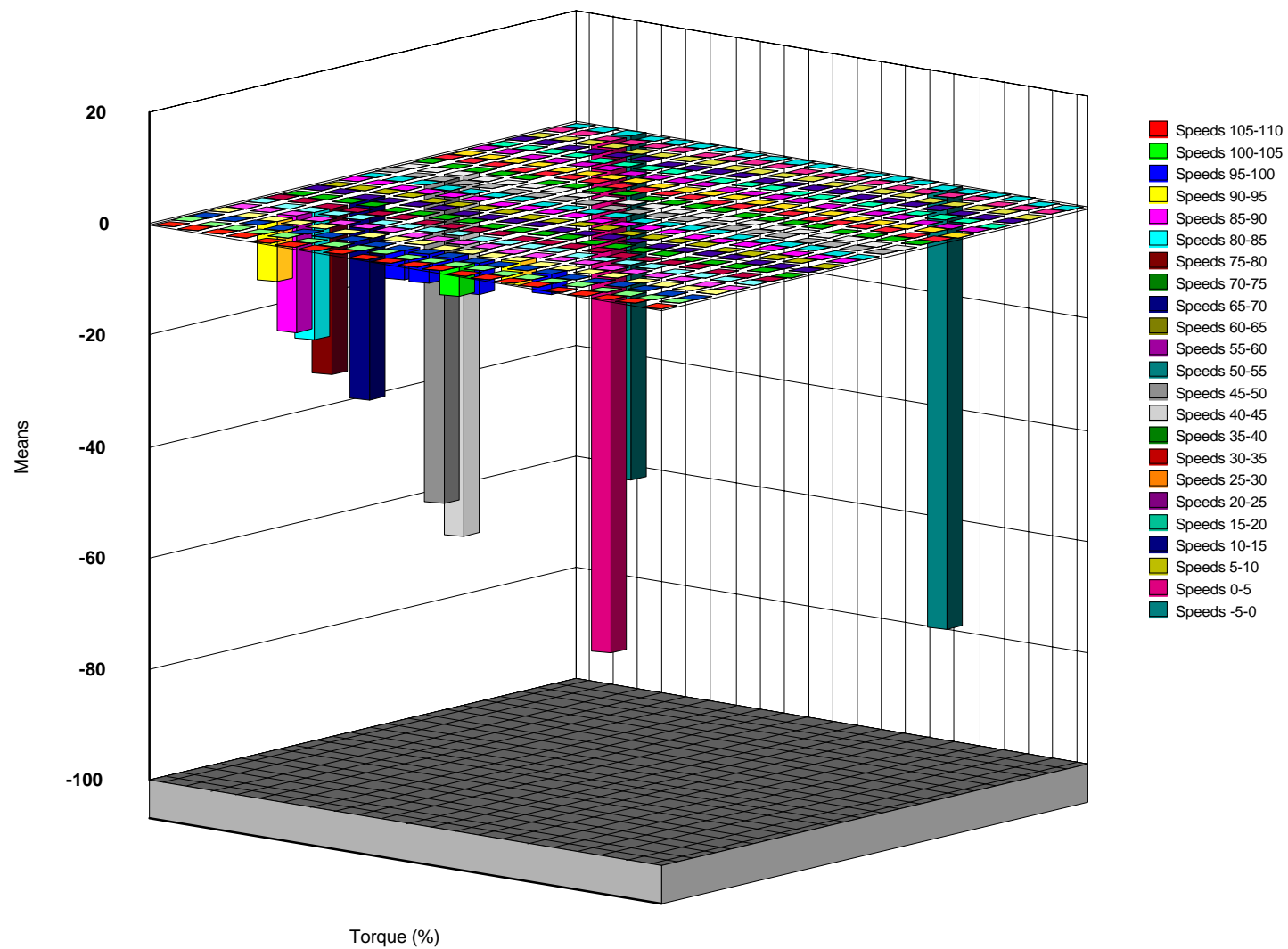
## WELDER TYPICAL 1--Speed Deceleration Counts



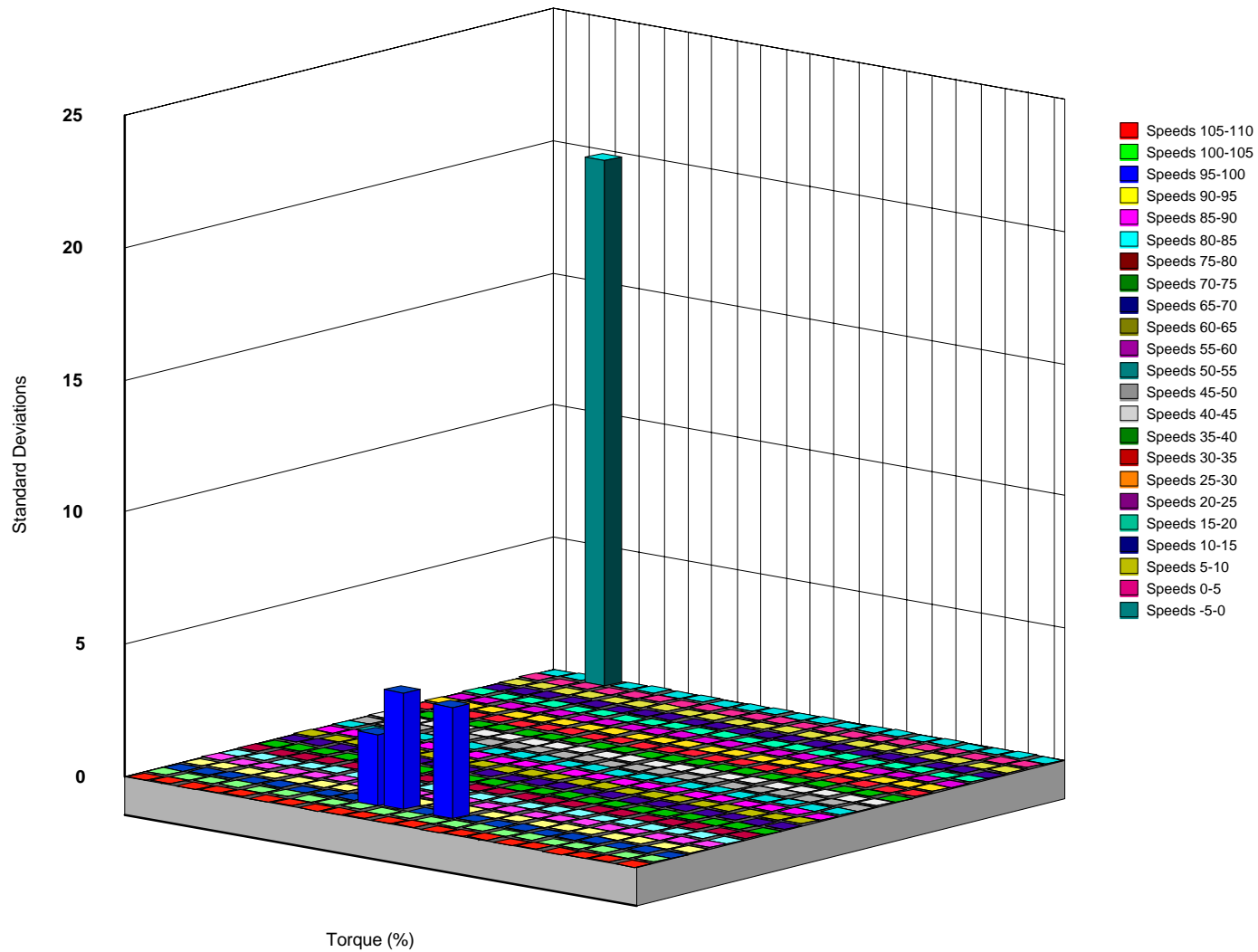
## WELDER TYPICAL 1--Speed Deceleration Sums



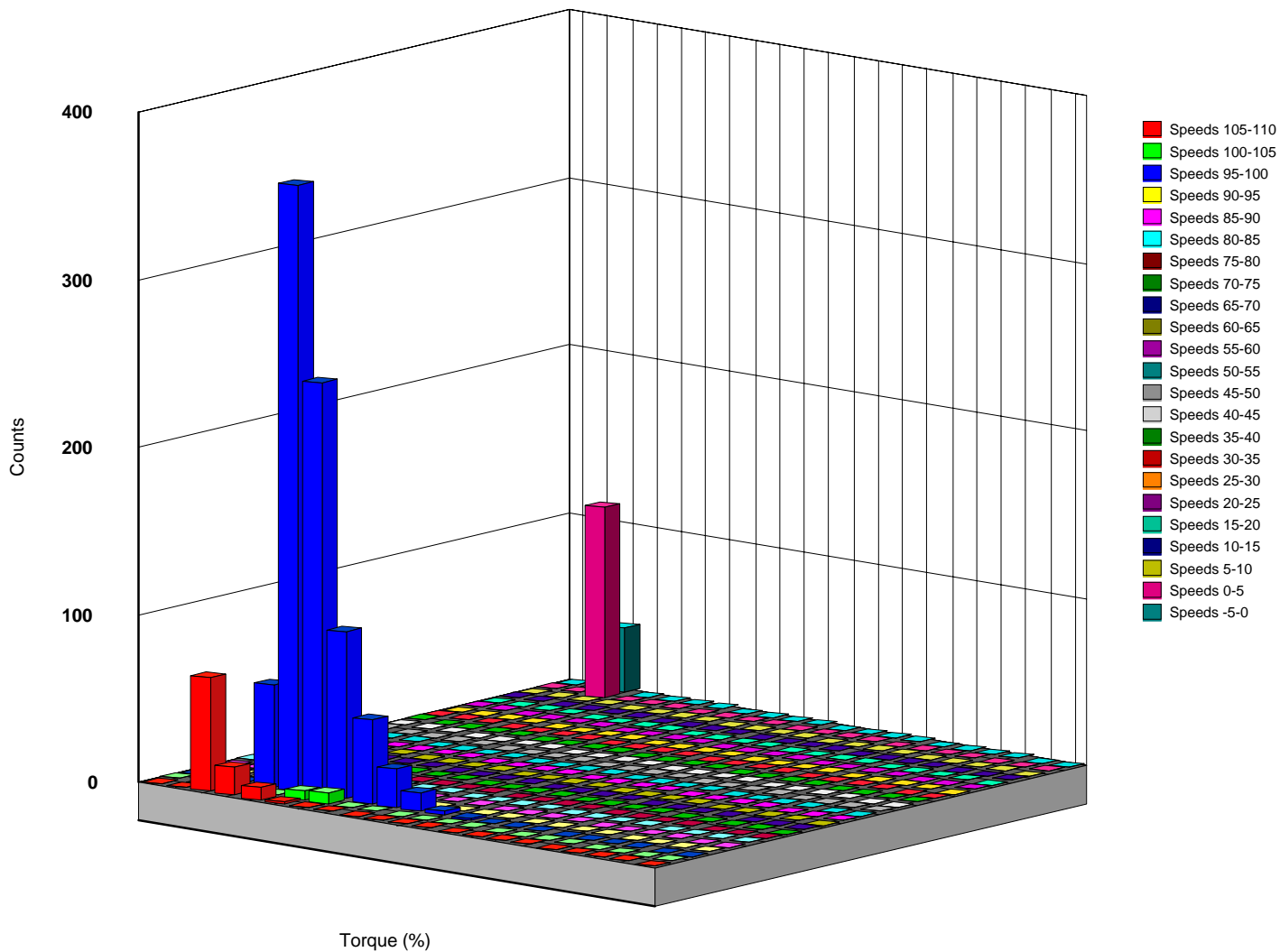
## WELDER TYPICAL 1--Speed Deceleration Means



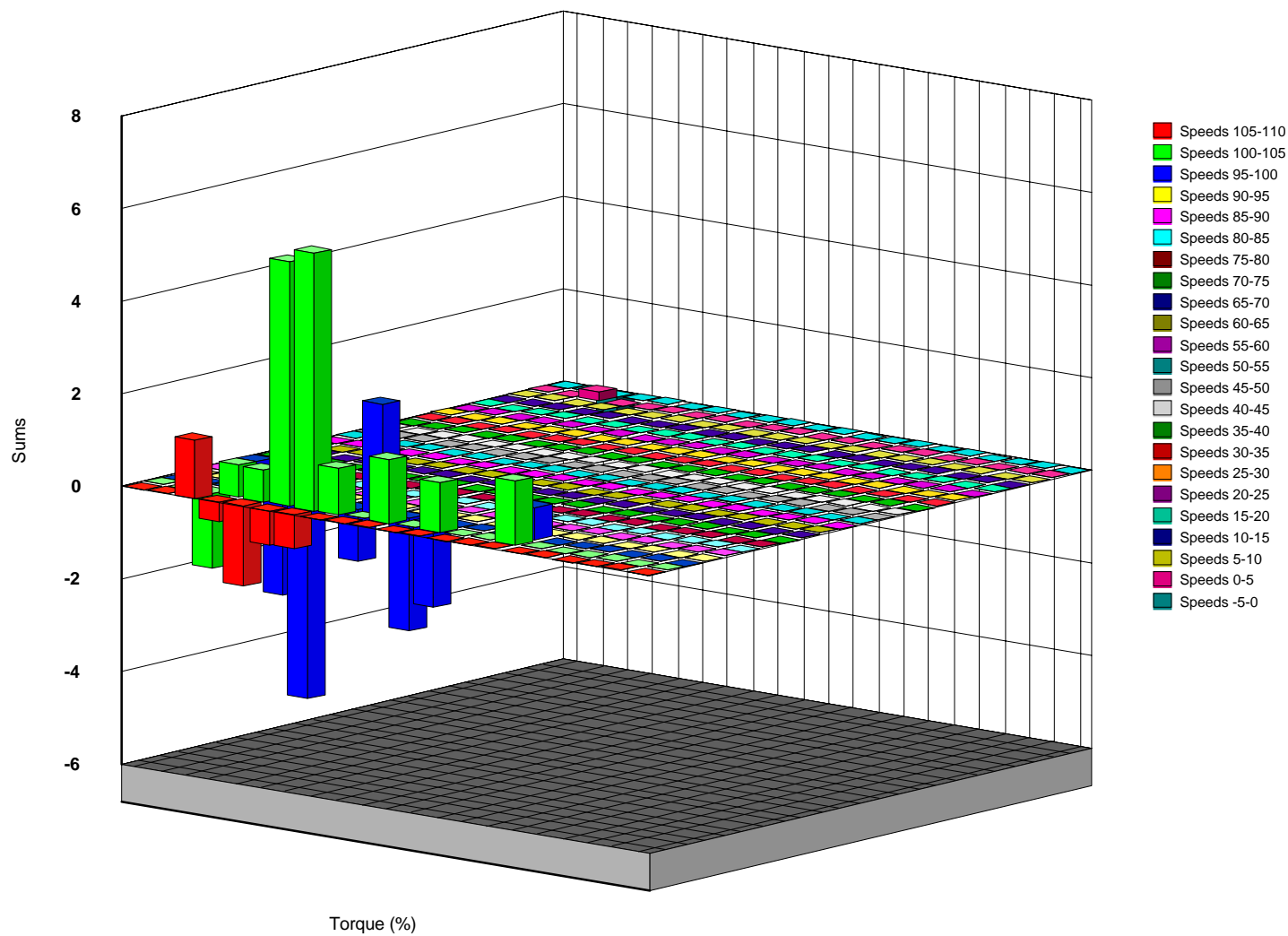
## WELDER TYPICAL 1--Speed Deceleration Standard Deviations



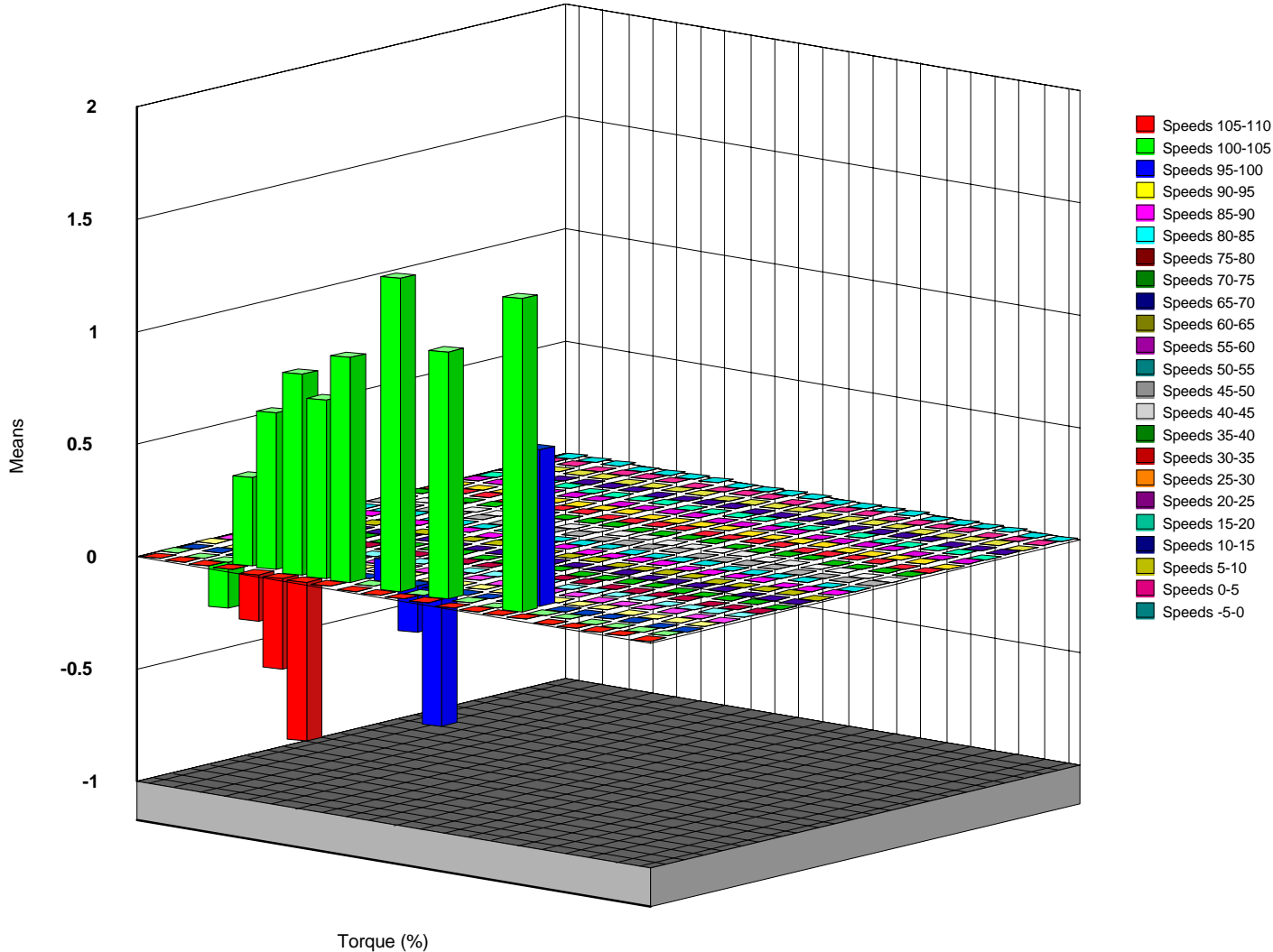
WELDER TYPICAL 1--Speed Steady State Counts



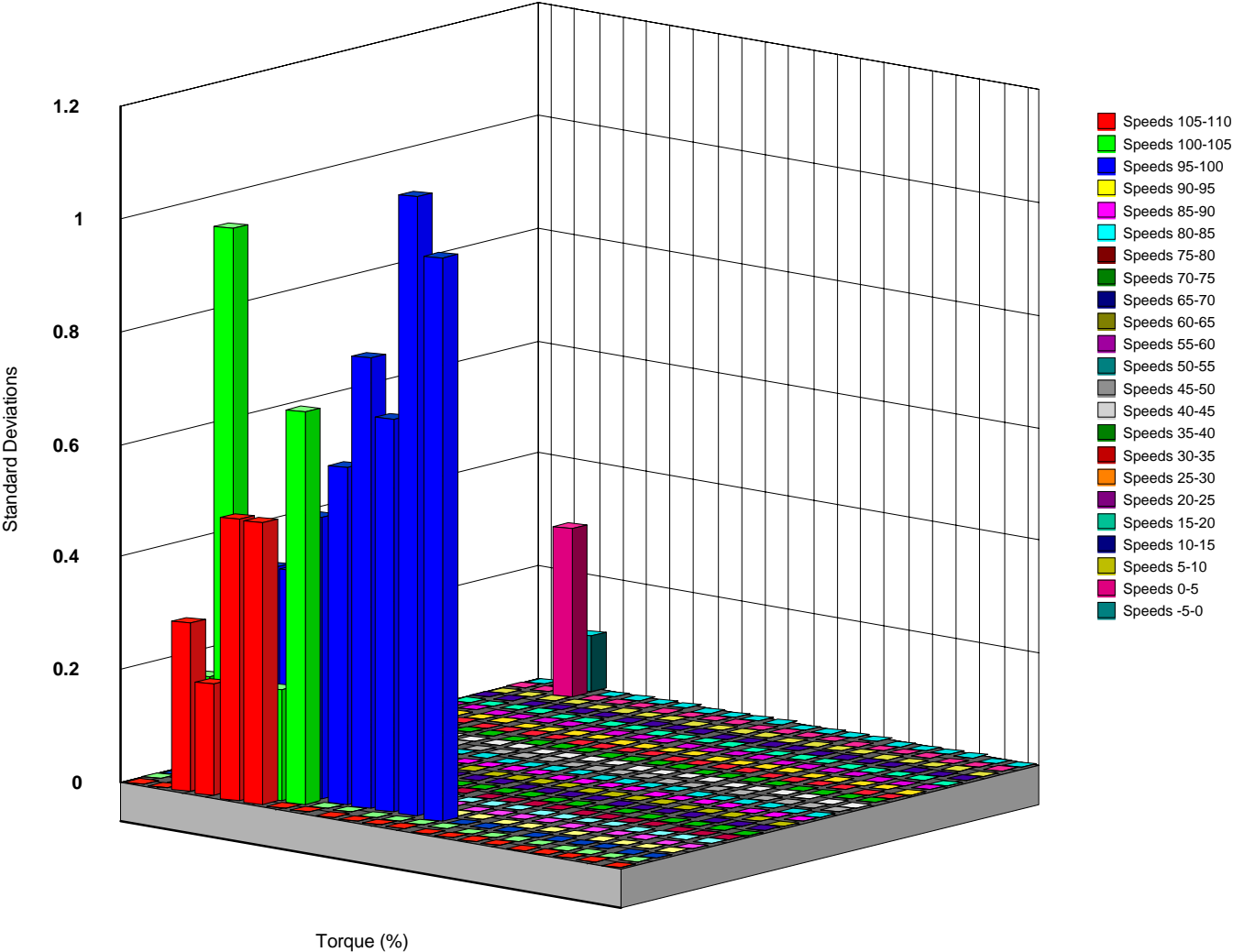
WELDER TYPICAL 1--Speed Steady State Sums



WELDER TYPICAL 1--Speed Steady State Means

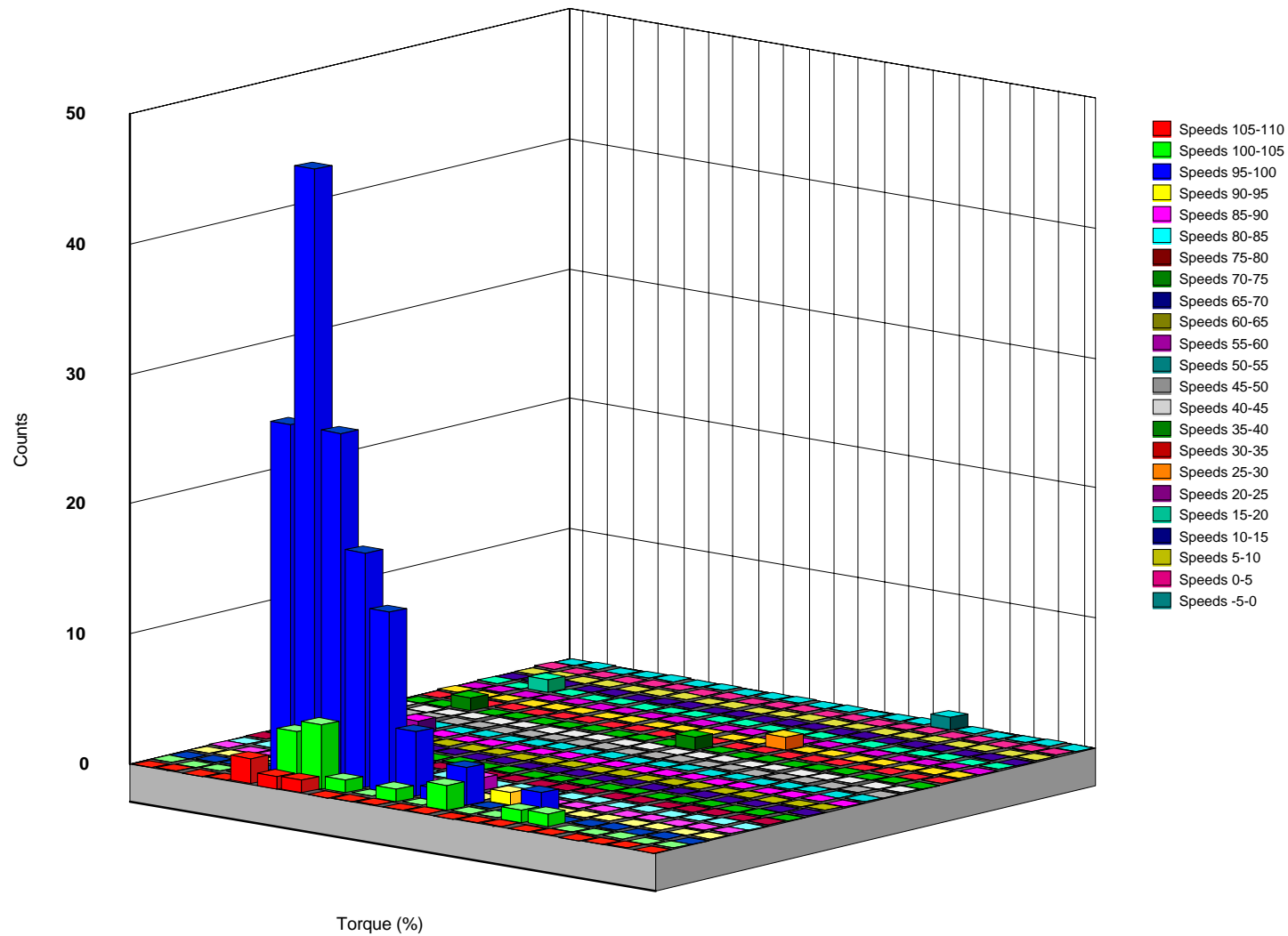


WELDER TYPICAL 1--Speed Steady State Standard Deviations

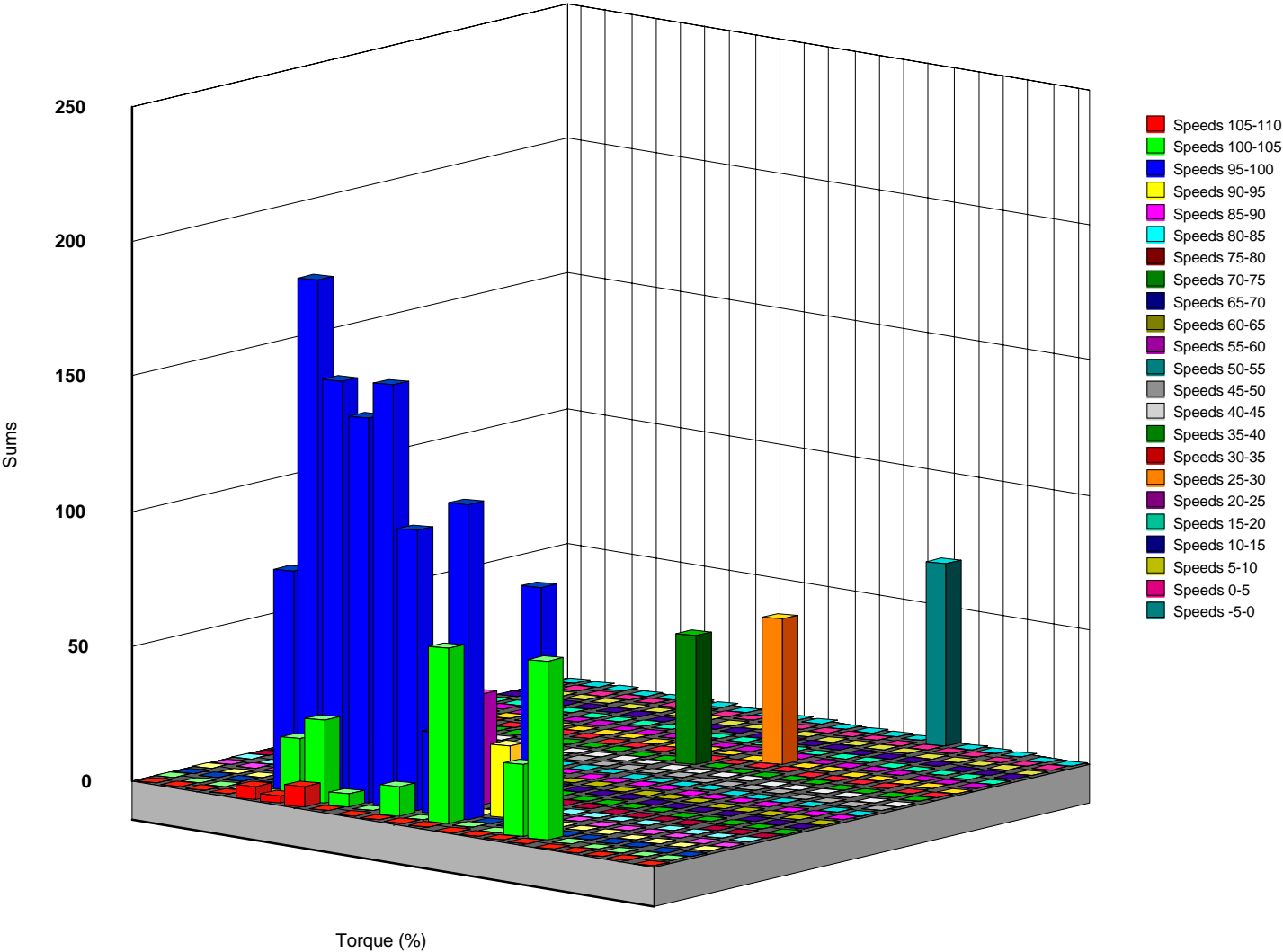




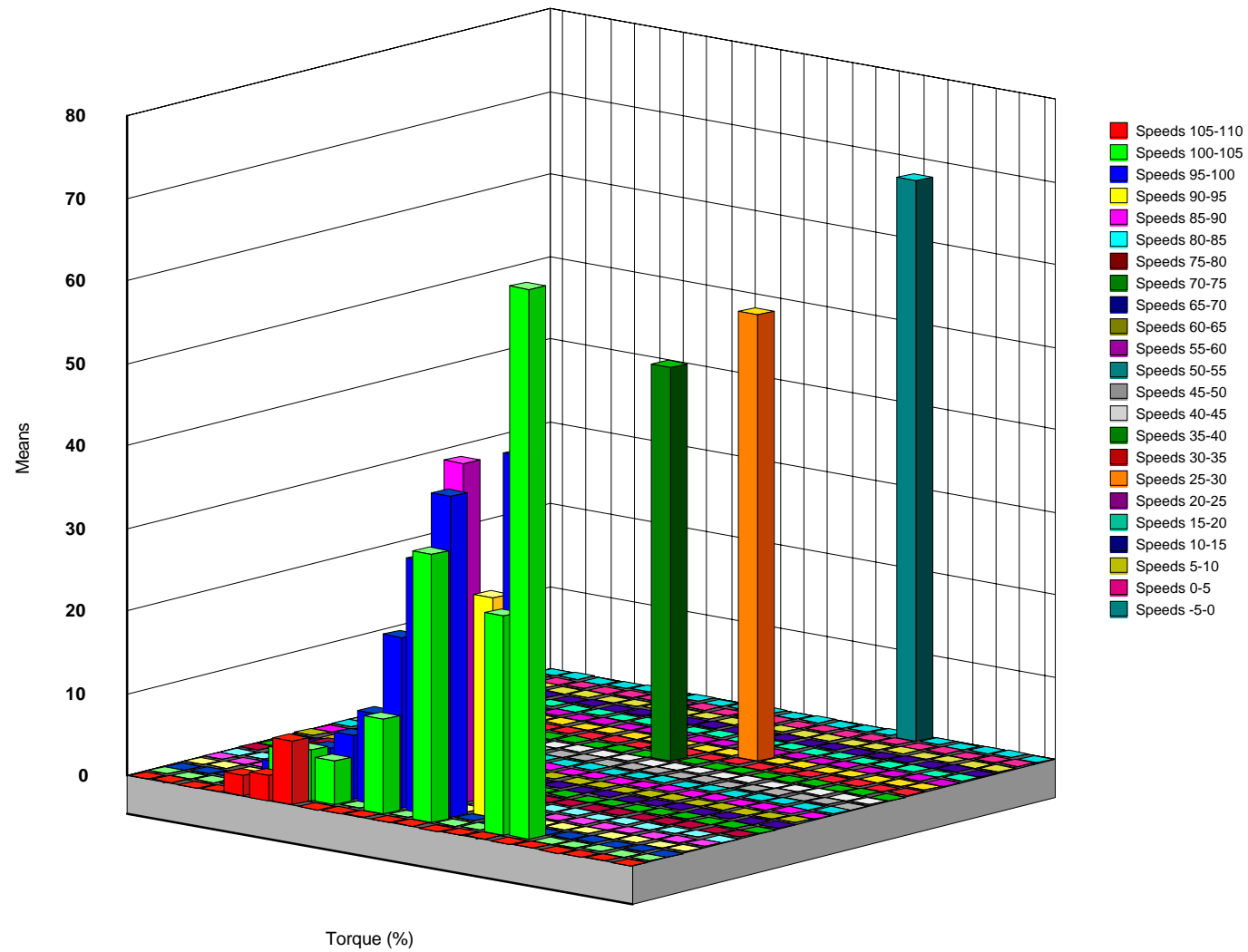
## WELDER TYPICAL 1--Torque Acceleration Counts



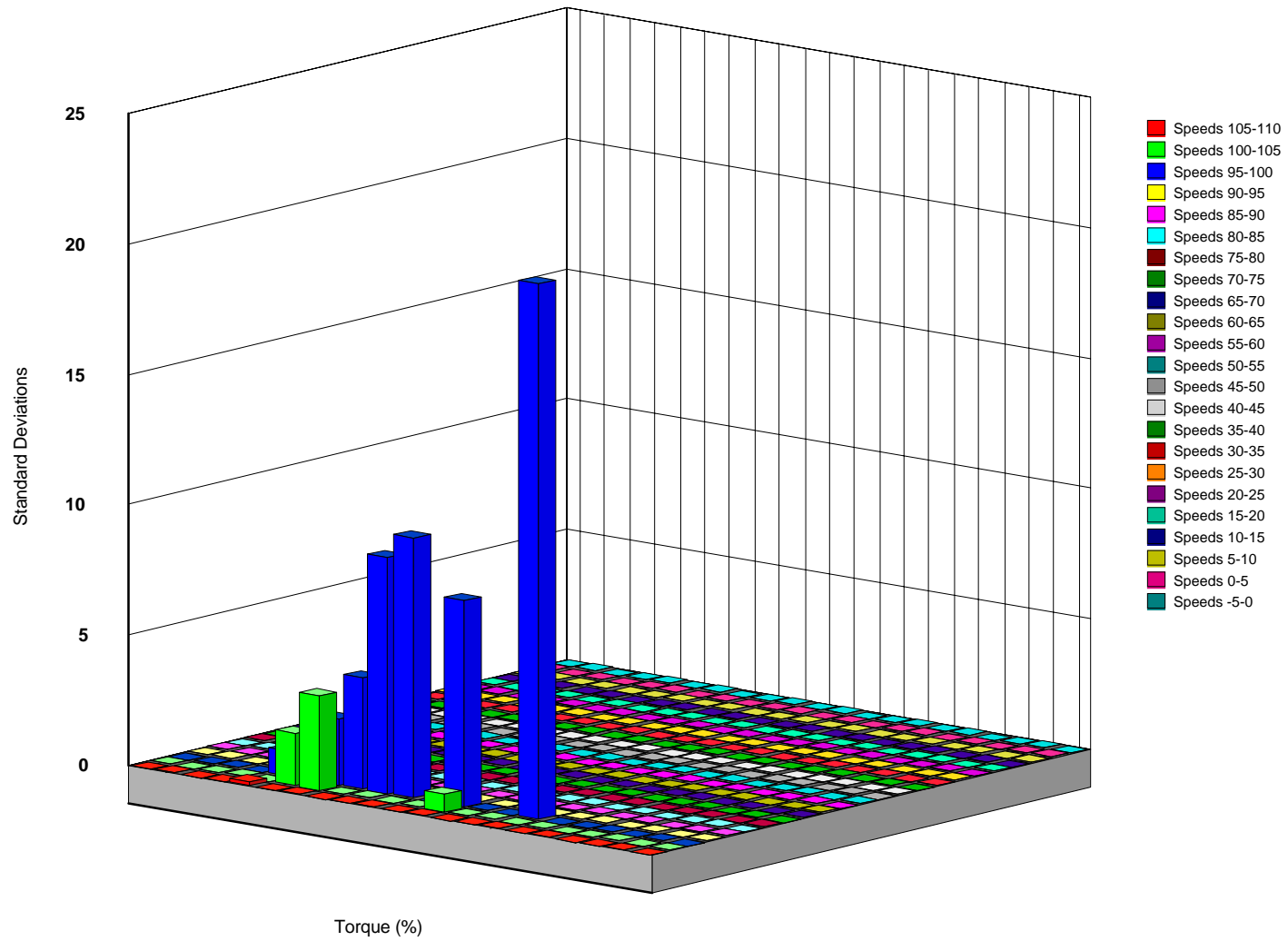
WELDER TYPICAL 1--Torque Acceleration Sums



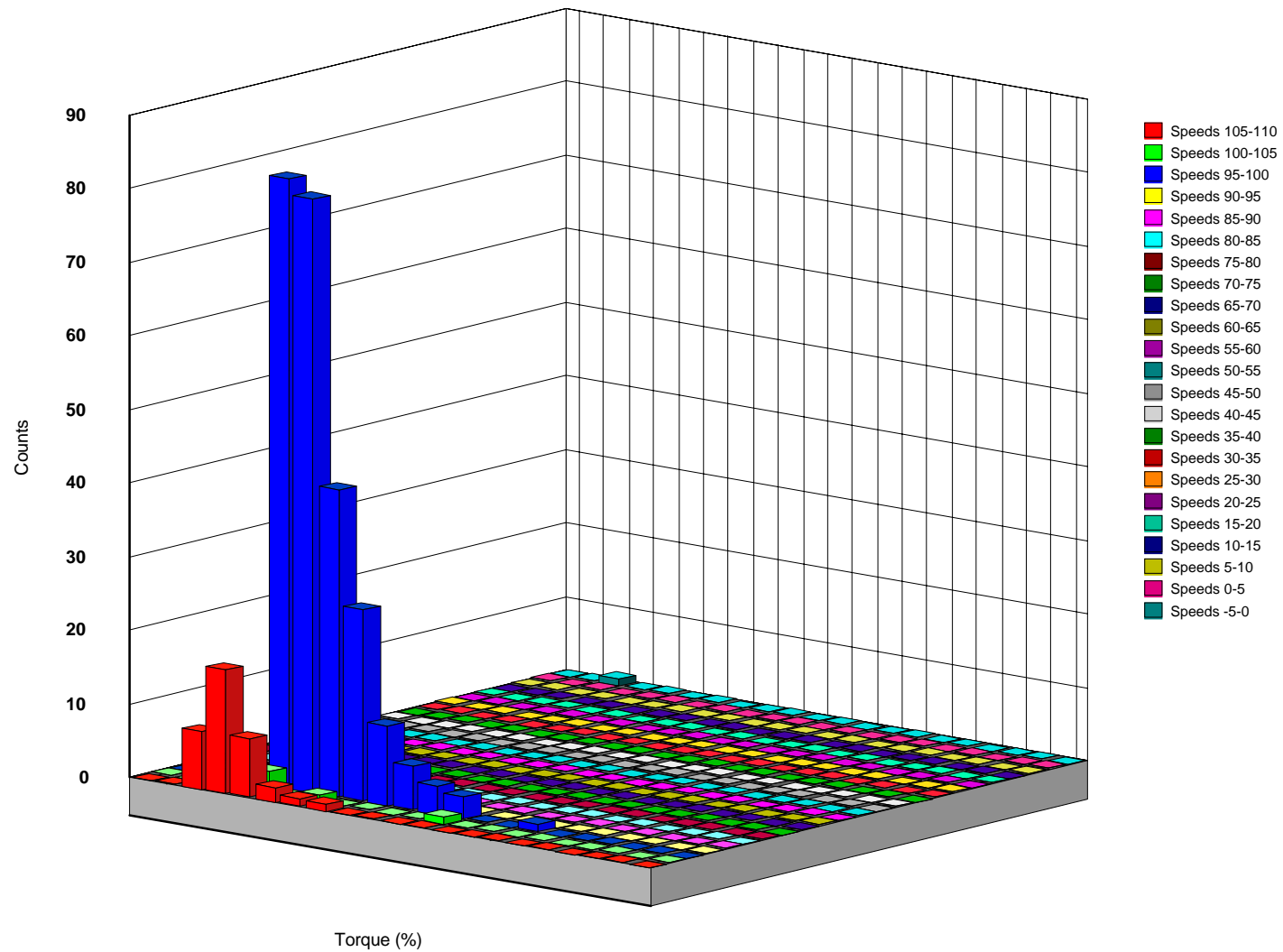
## WELDER TYPICAL 1--Torque Acceleration Means



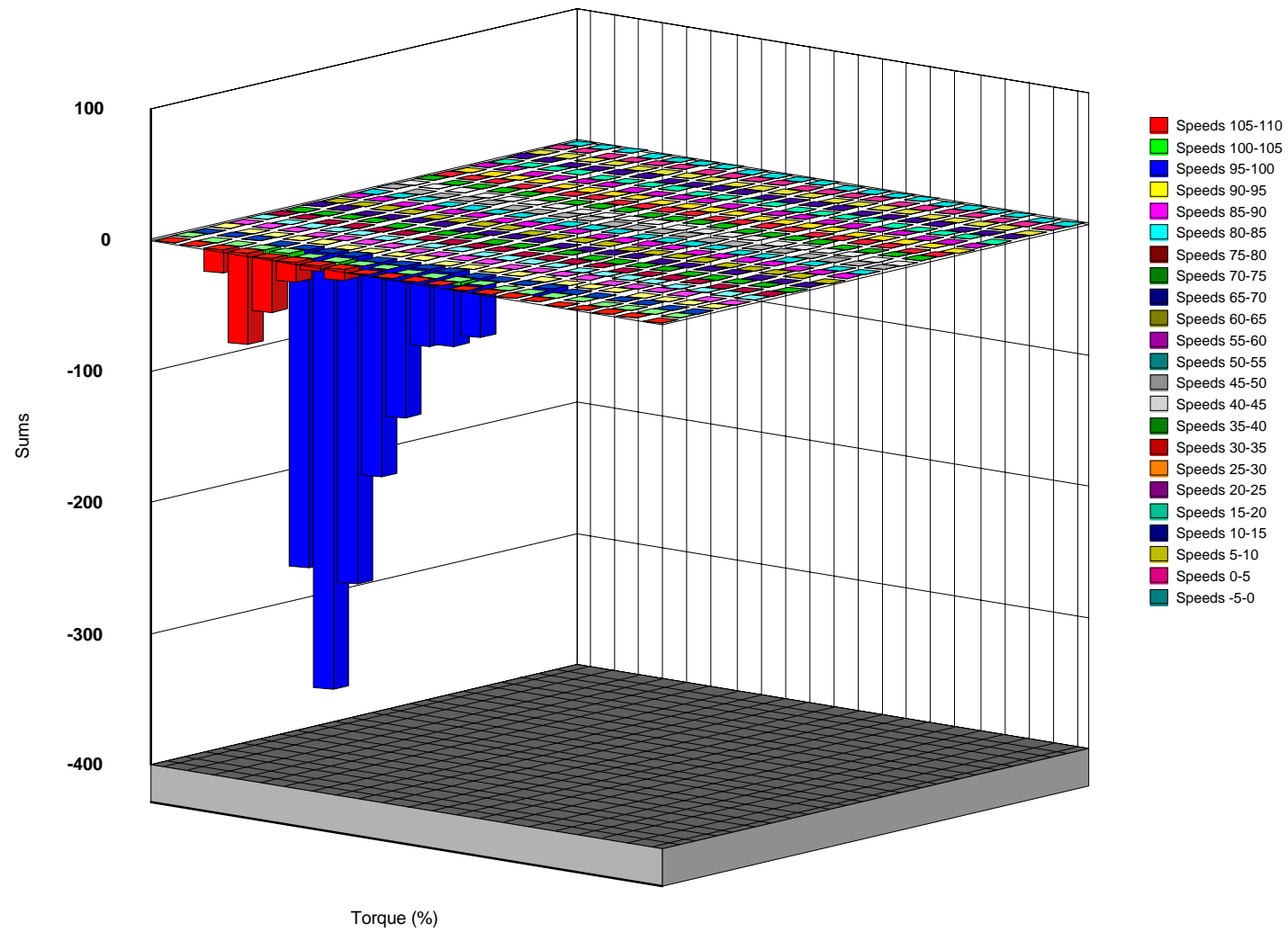
## WELDER TYPICAL 1--Torque Acceleration Standard Deviations



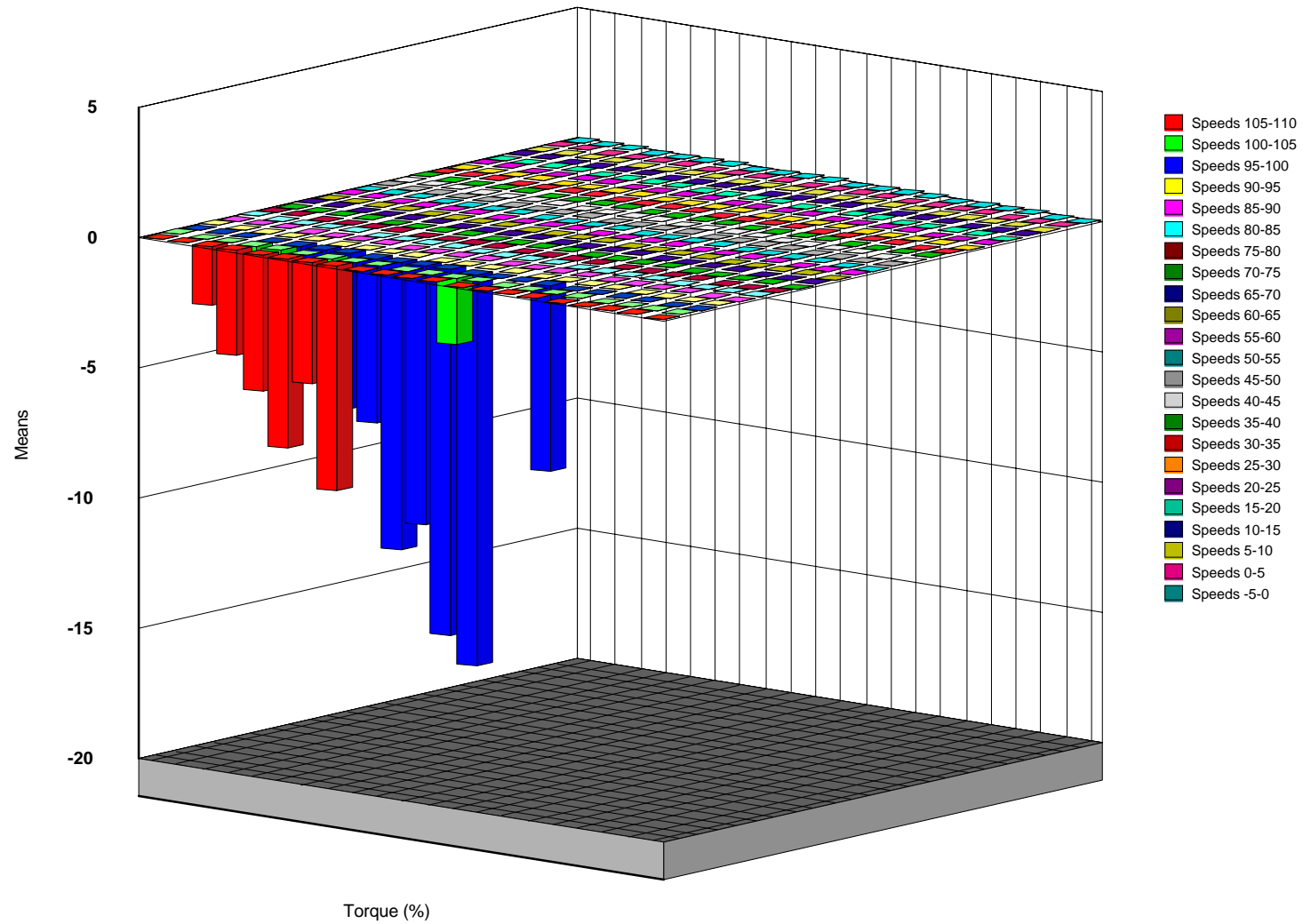
## WELDER TYPICAL 1--Torque Deceleration Counts



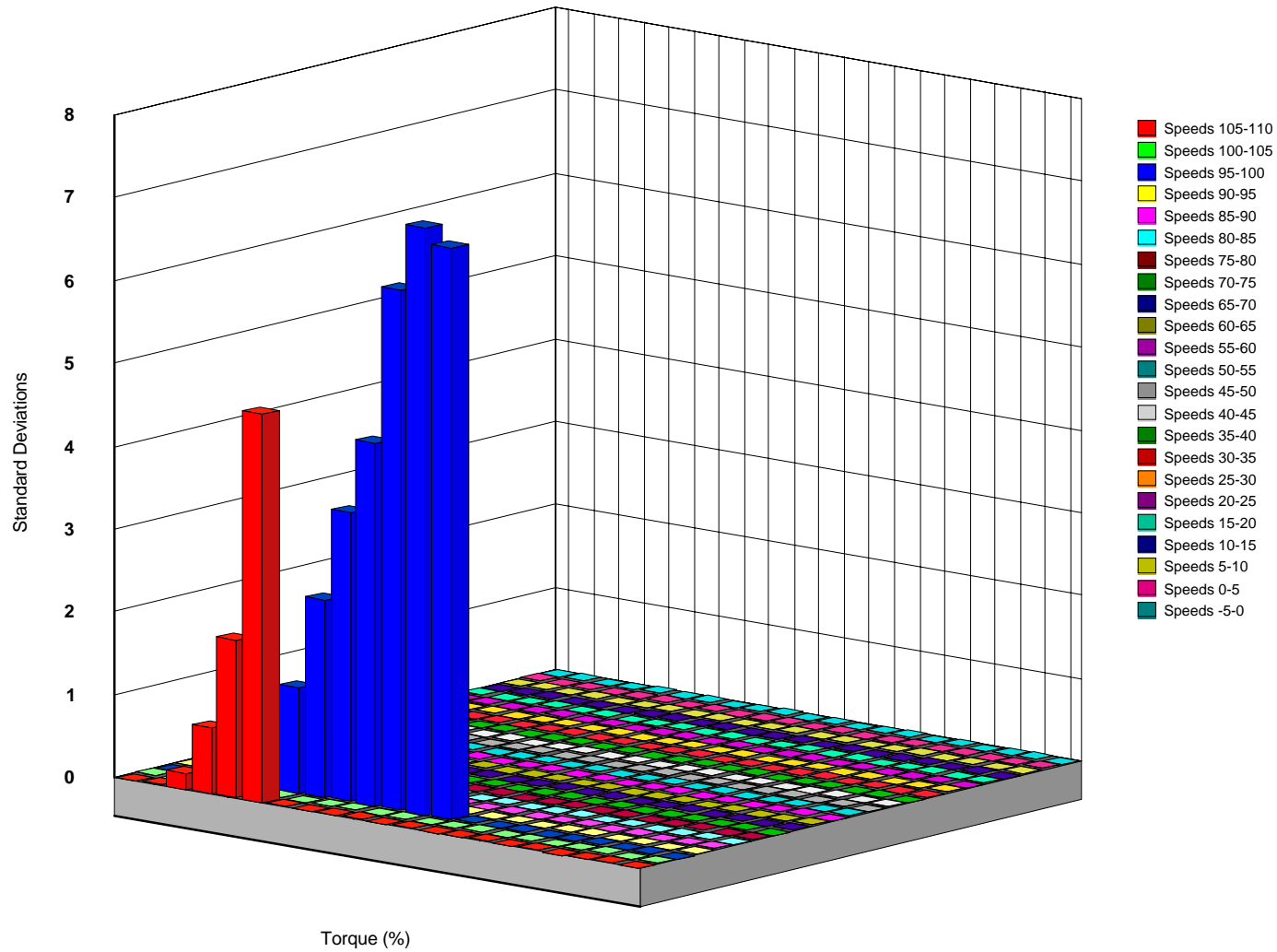
## WELDER TYPICAL 1--Torque Deceleration Sums



## WELDER TYPICAL 1--Torque Deceleration Means

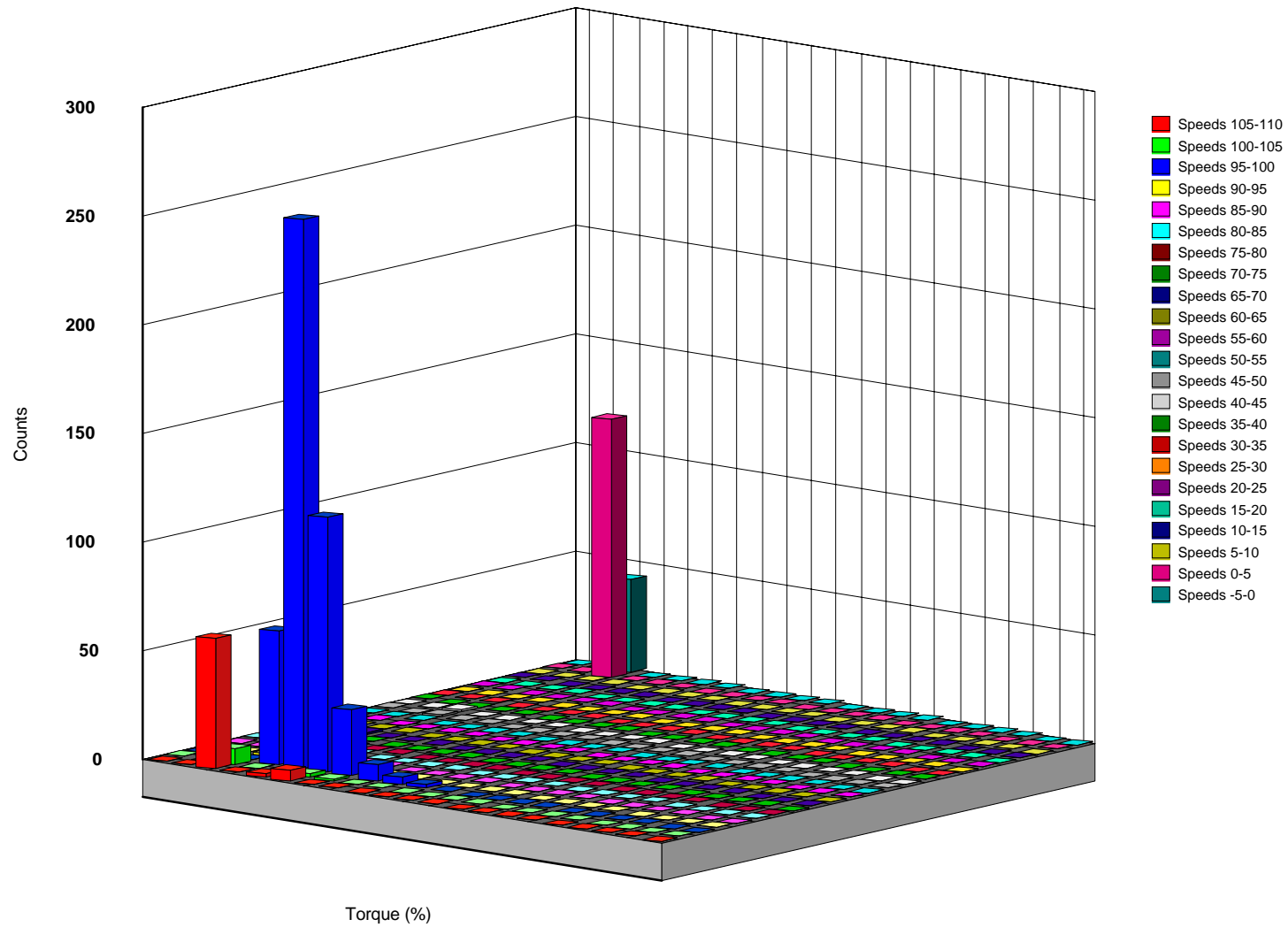


## WELDER TYPICAL 1--Torque Deceleration Standard Deviations

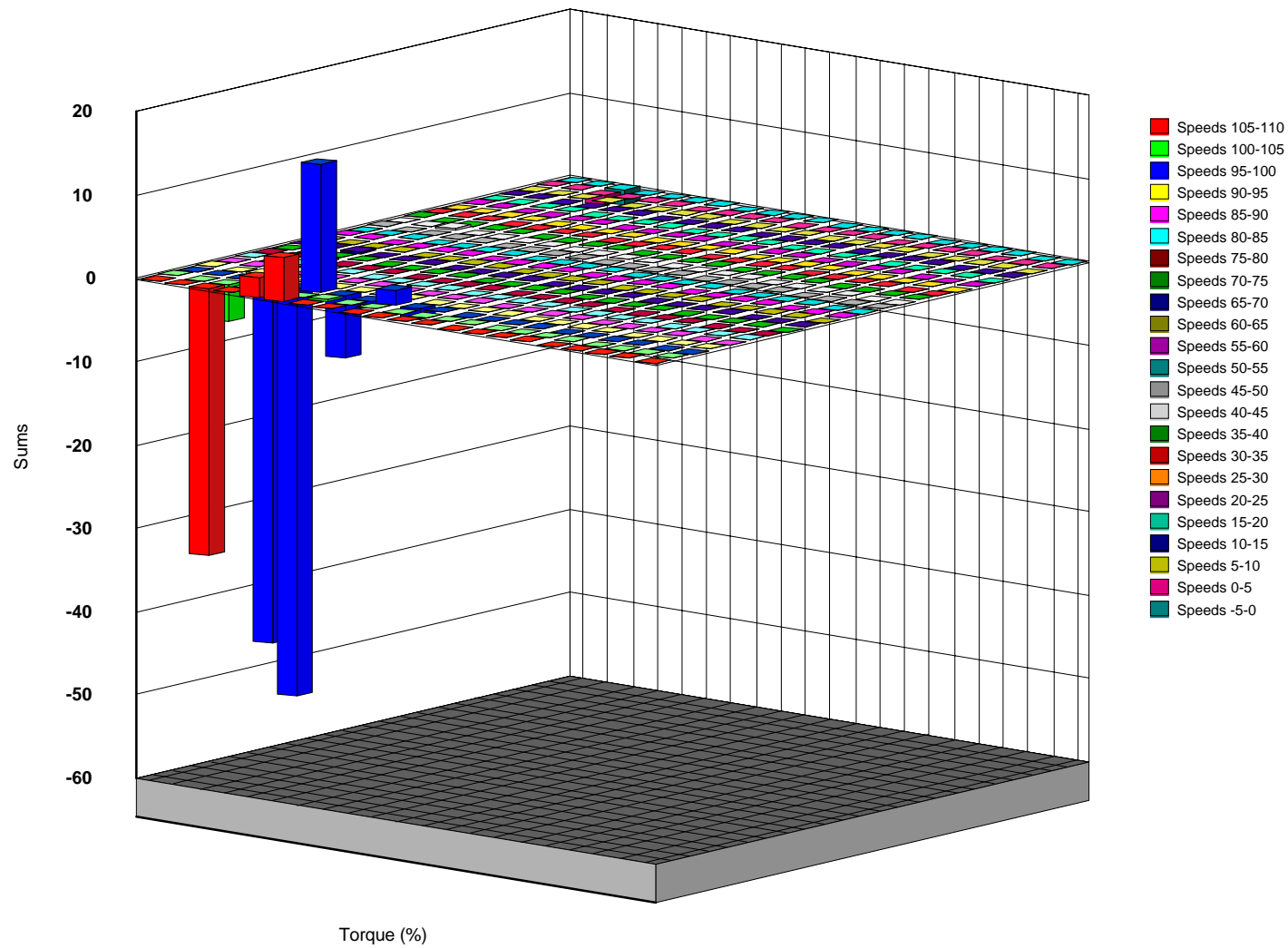




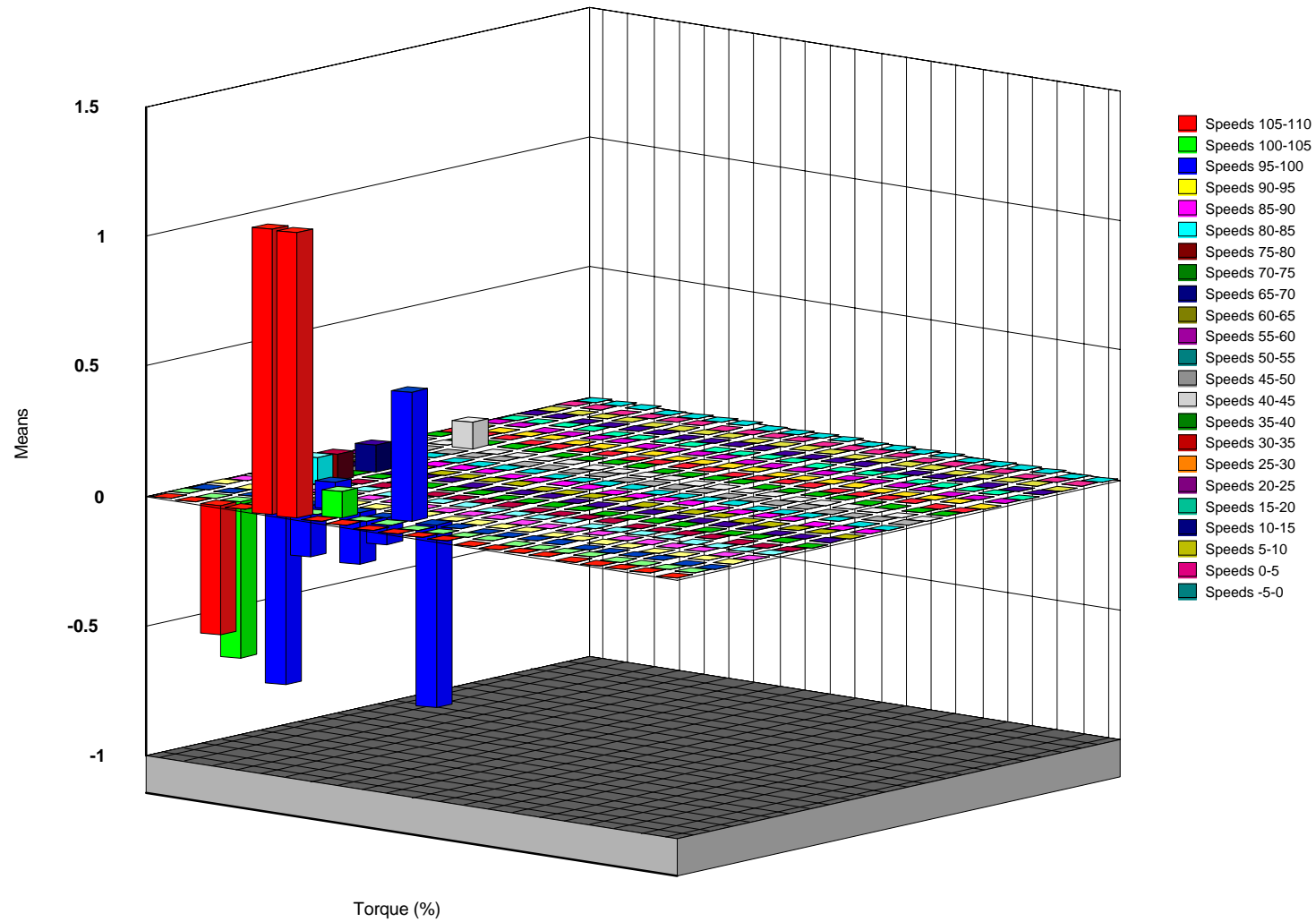
## WELDER TYPICAL 1--Torque Steady State Counts



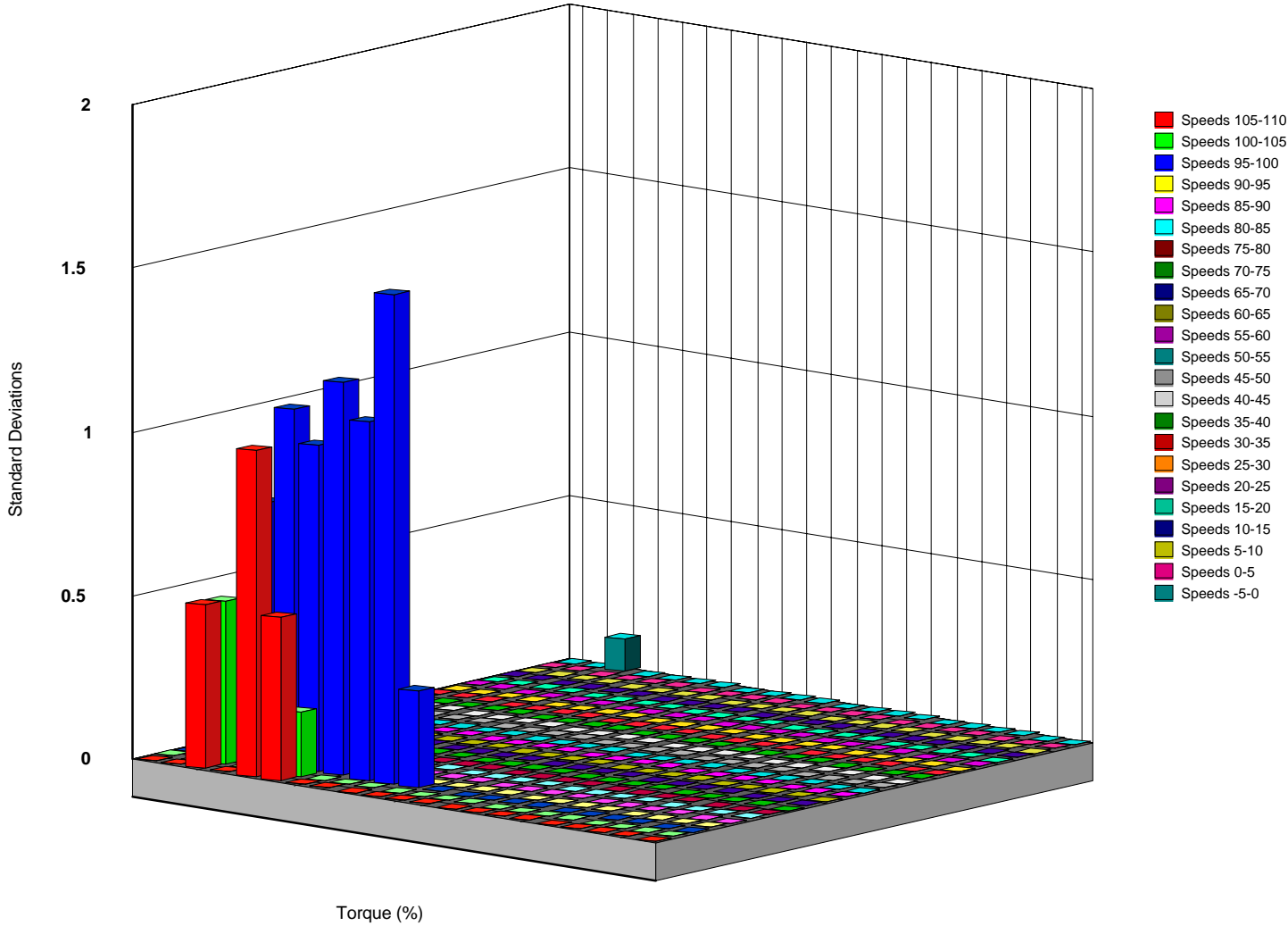
## WELDER TYPICAL 1--Torque Steady State Sums



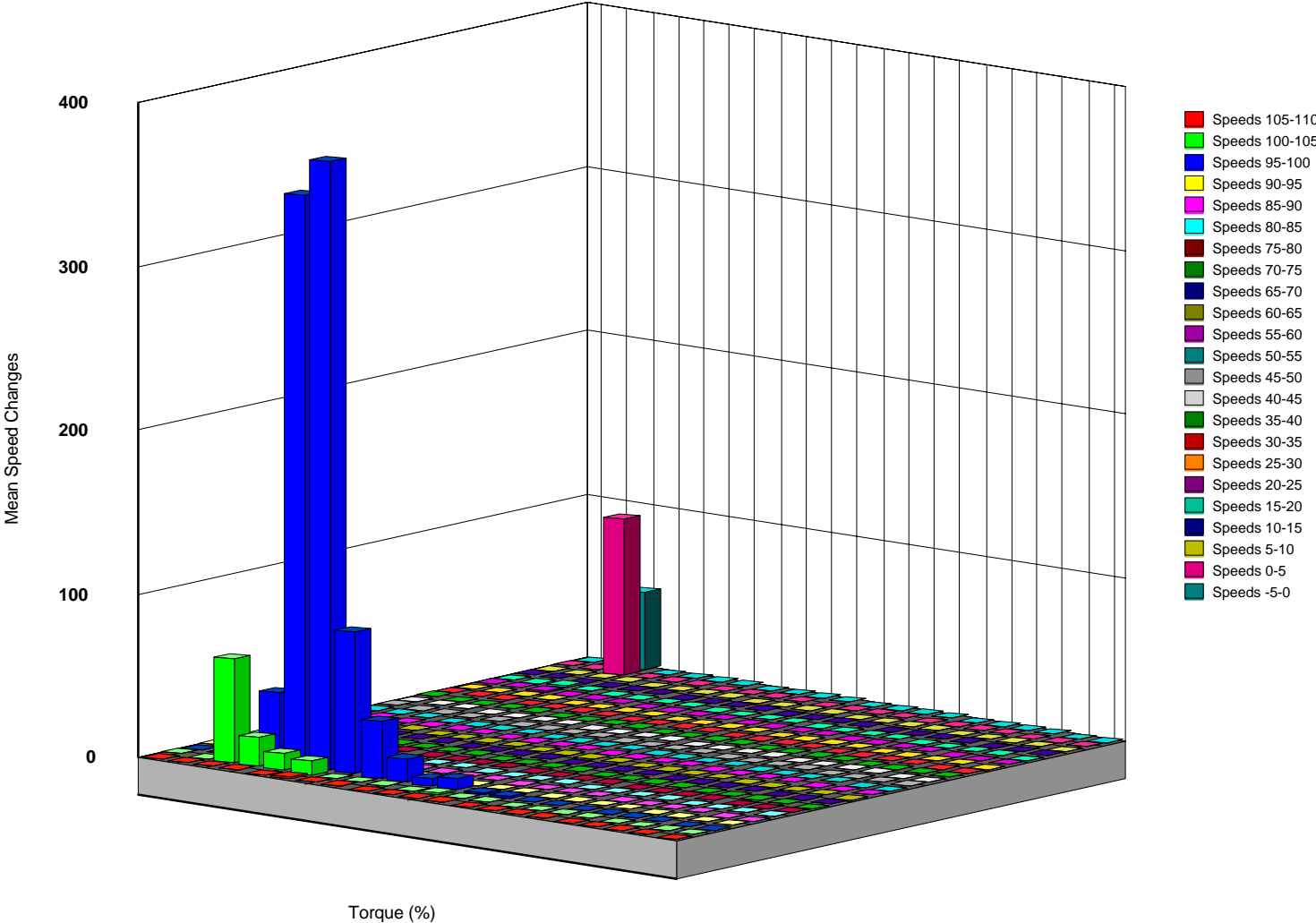
## WELDER TYPICAL 1--Torque Steady State Means



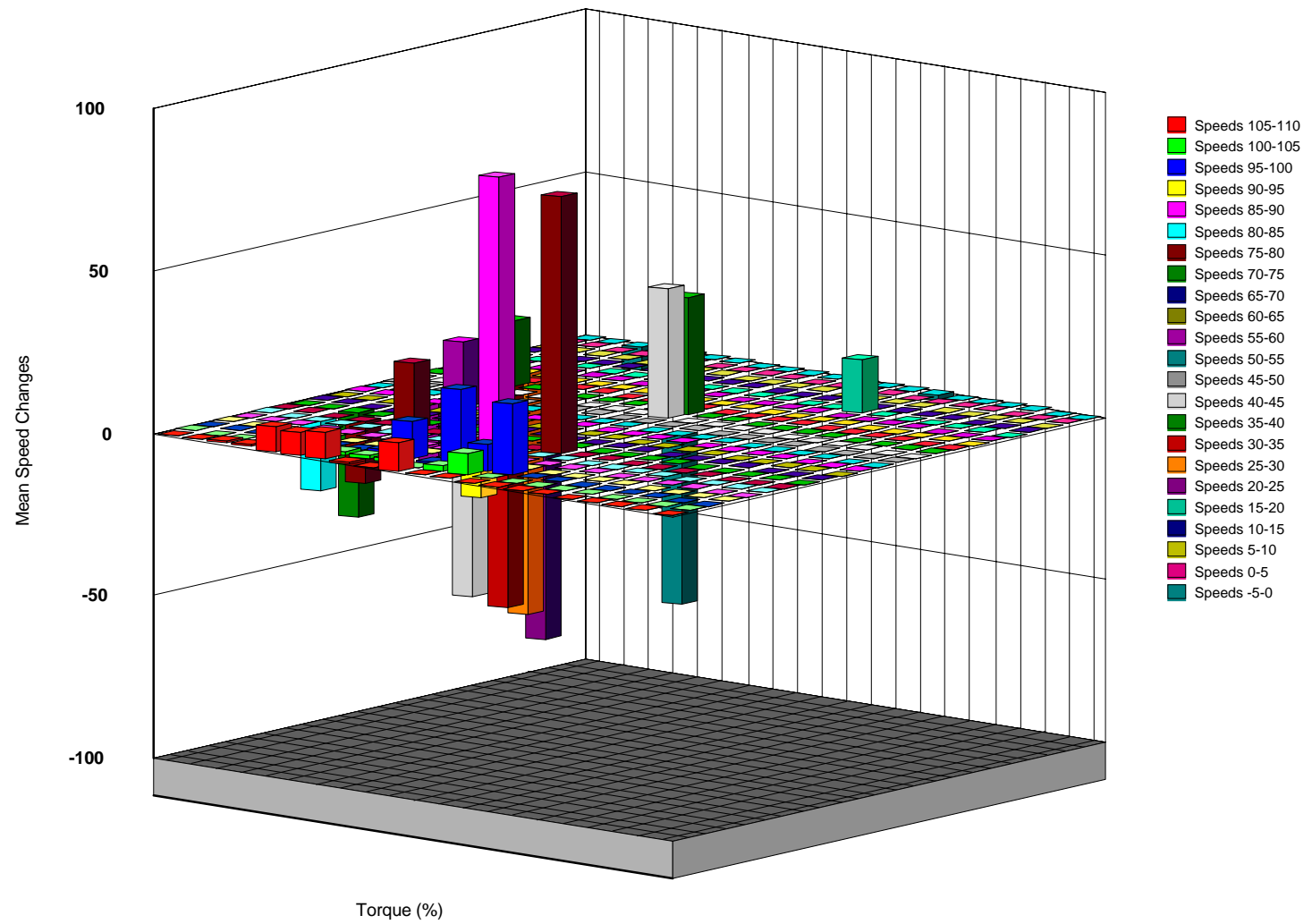
WELDER TYPICAL 1--Torque Steady State Standard Deviations



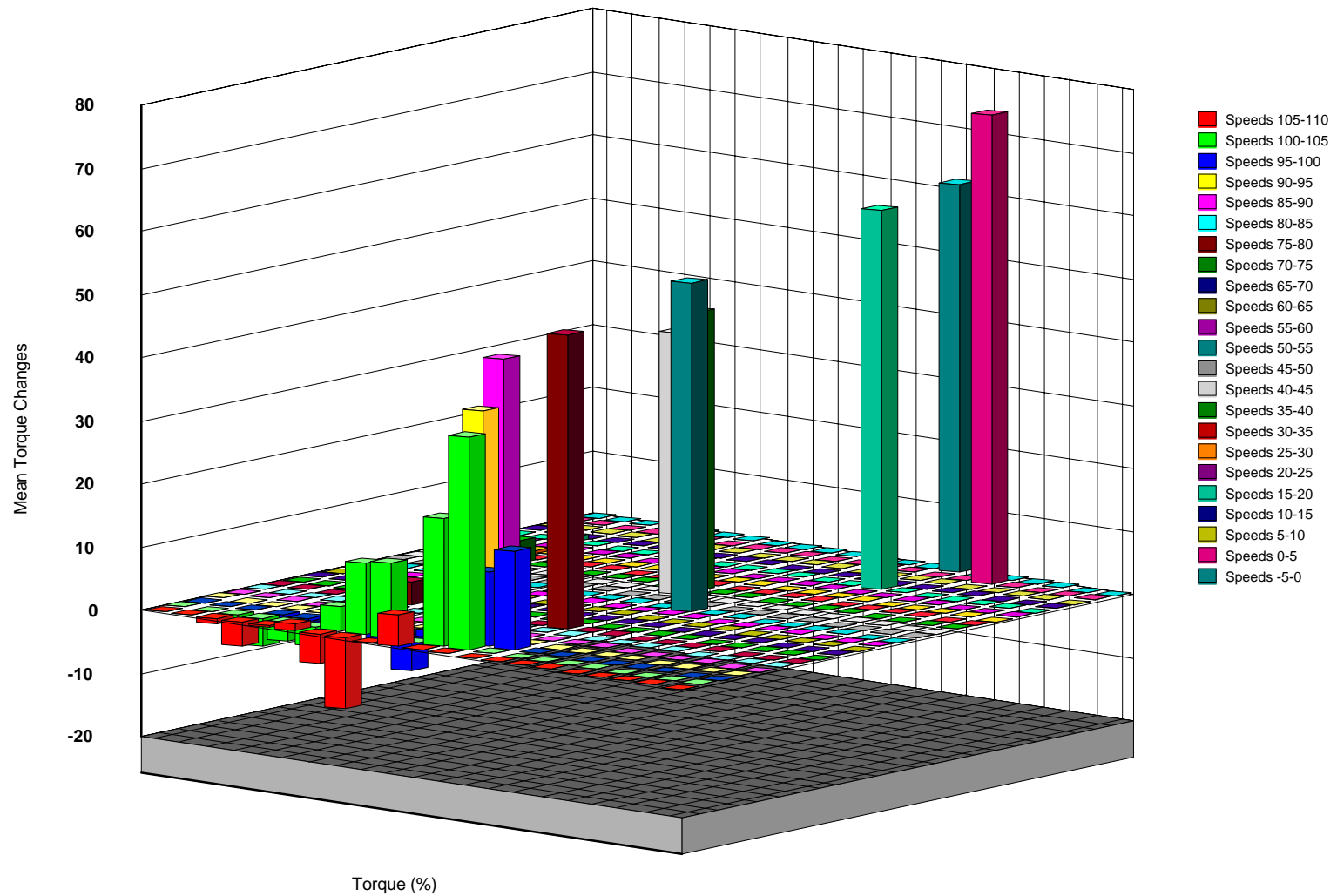
# WELDER TYPICAL 2--Counts



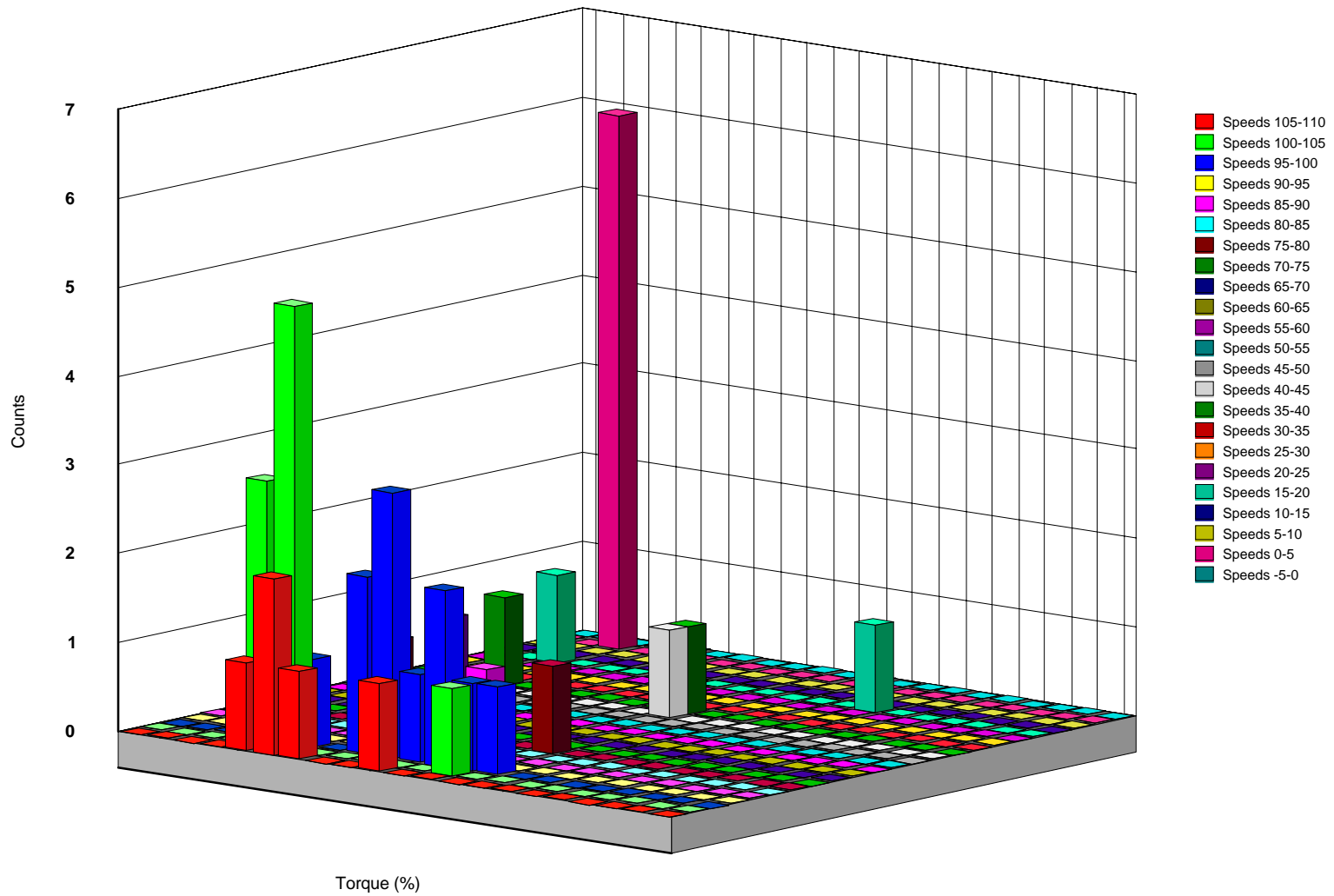
## WELDER TYPICAL 2--Mean Speed Changes



## WELDER TYPICAL 2--Mean Torque Changes

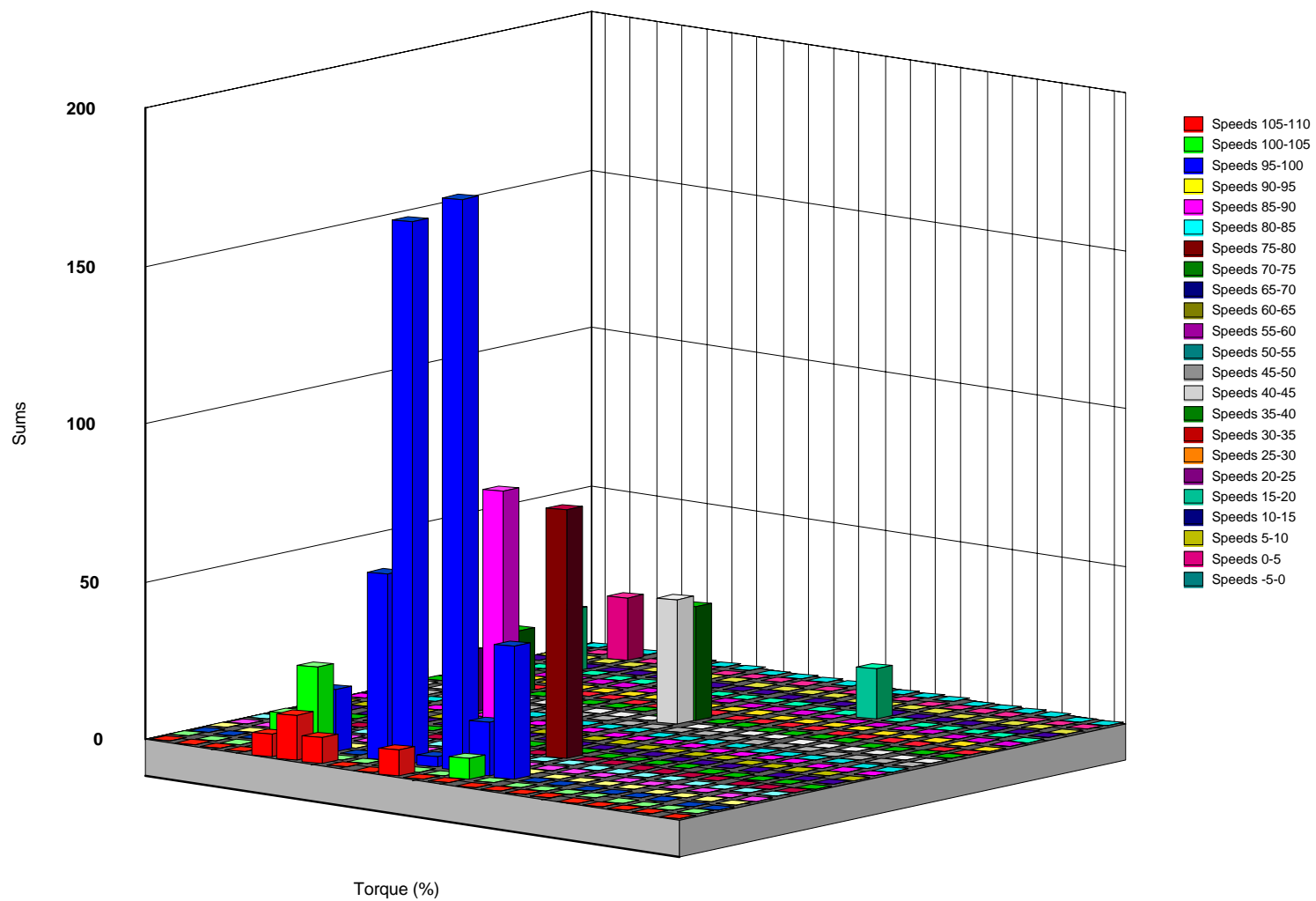


## WELDER TYPICAL 2--Speed Acceleration Counts

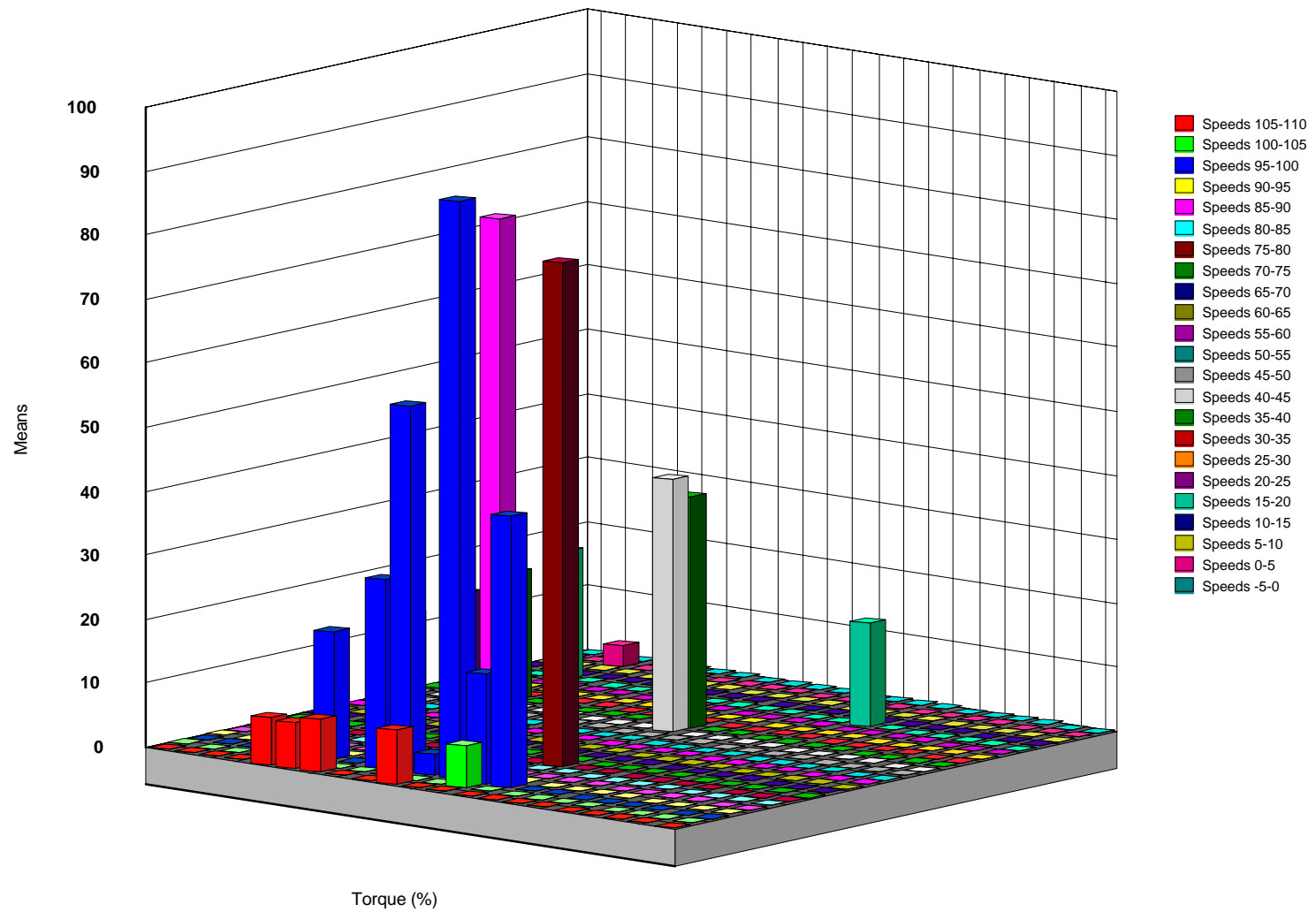




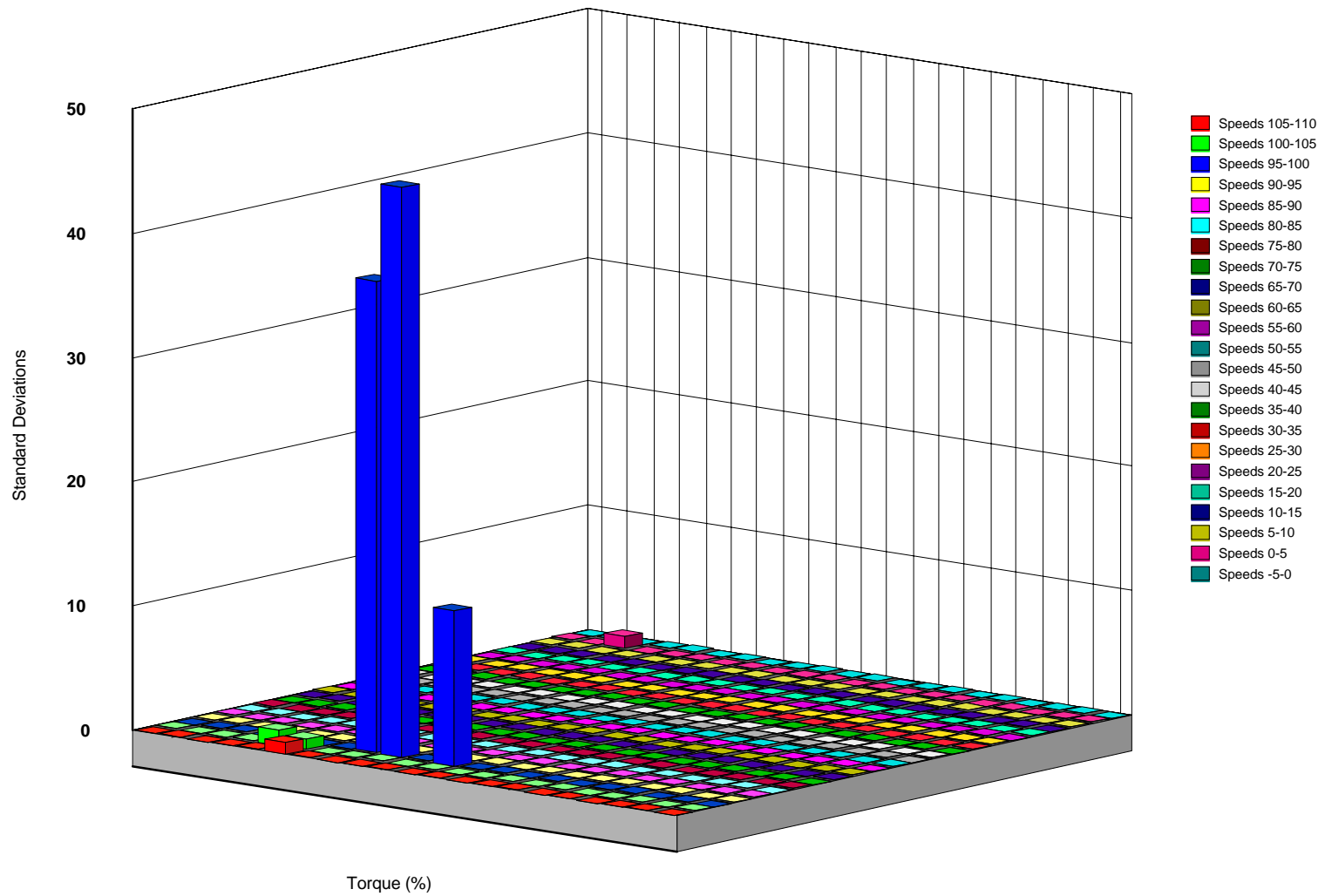
## WELDER TYPICAL 2--Speed Acceleration Sums



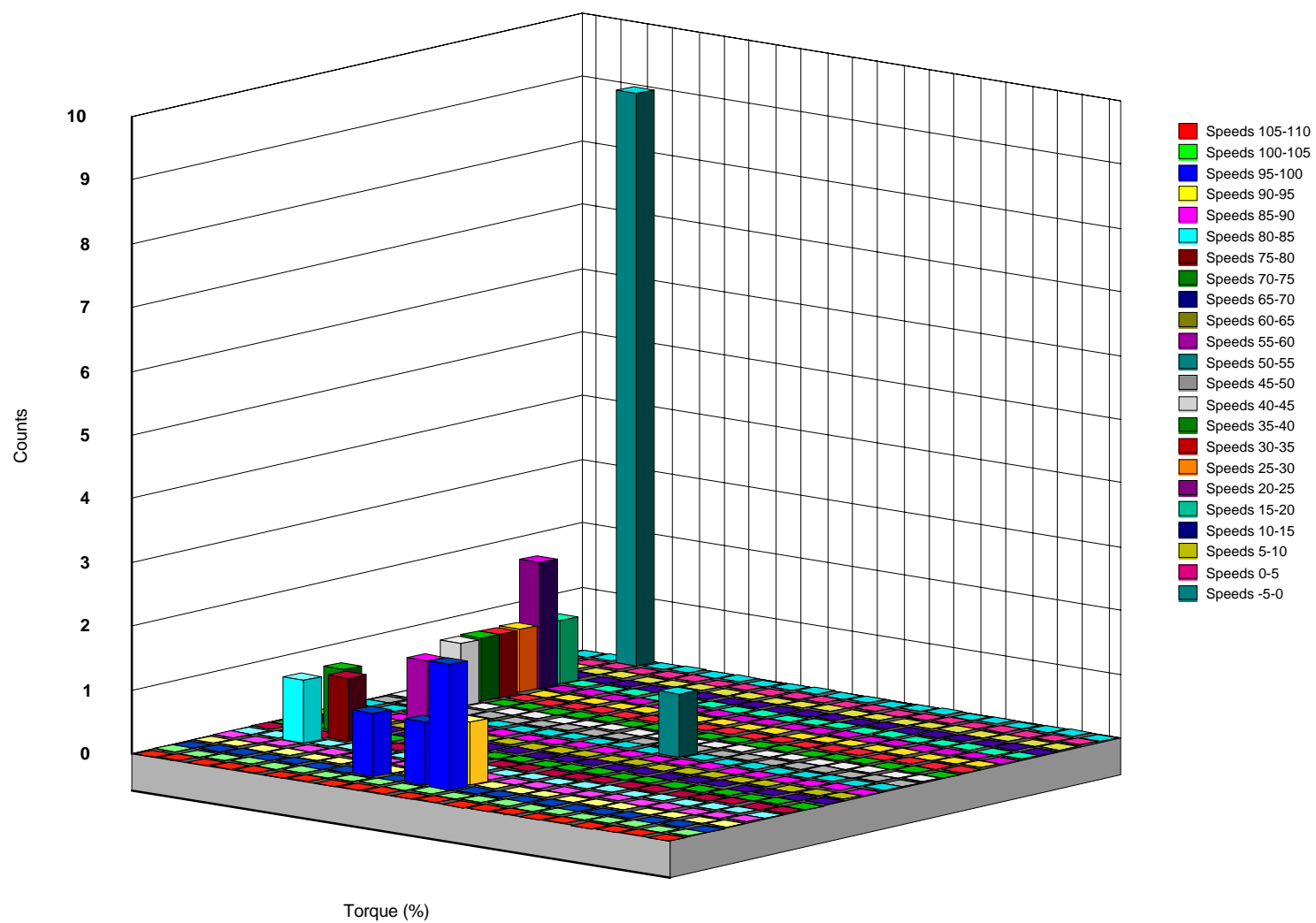
## WELDER TYPICAL 2--Speed Acceleration Means



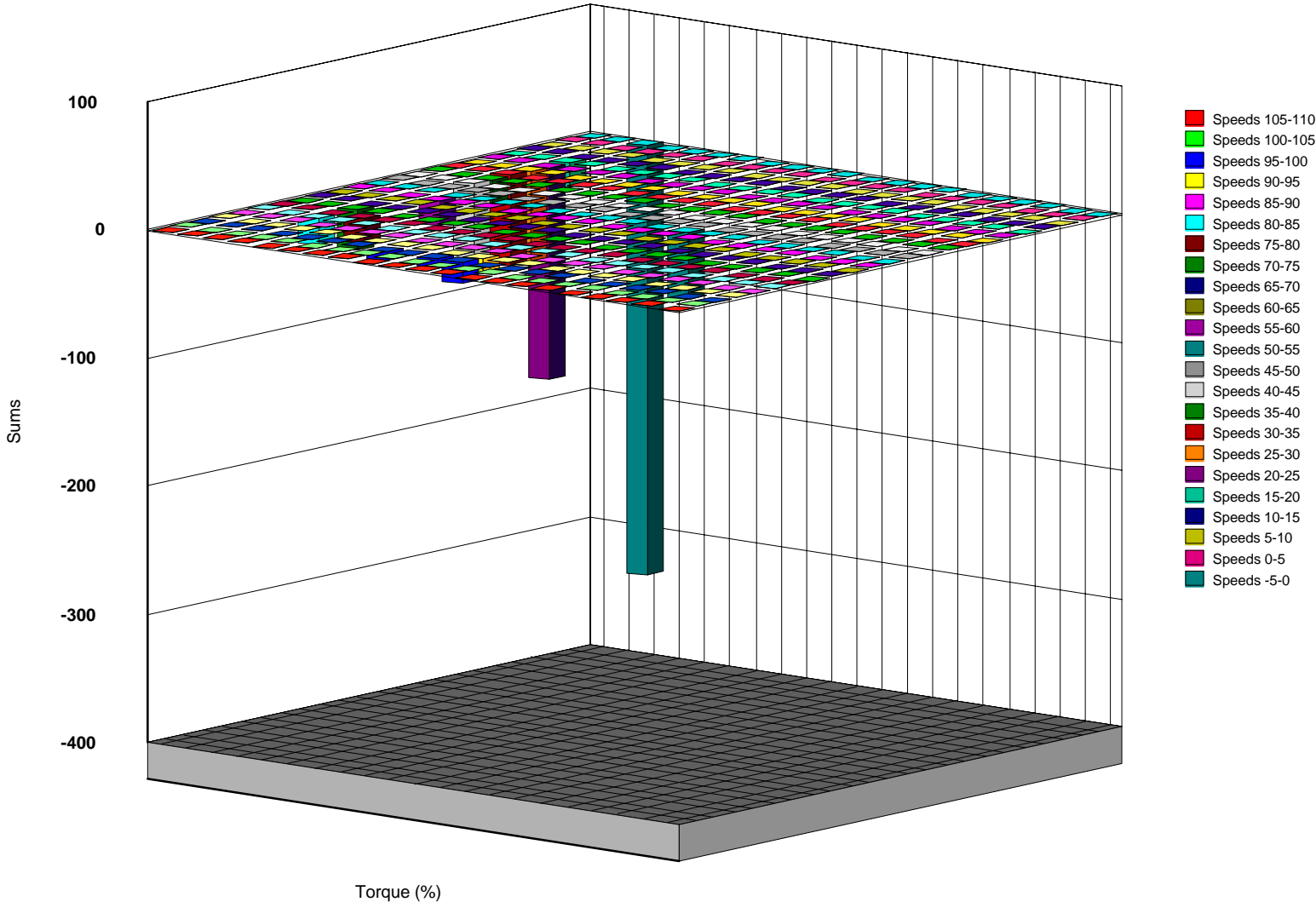
## WELDER TYPICAL 2--Speed Acceleration Standard Deviations



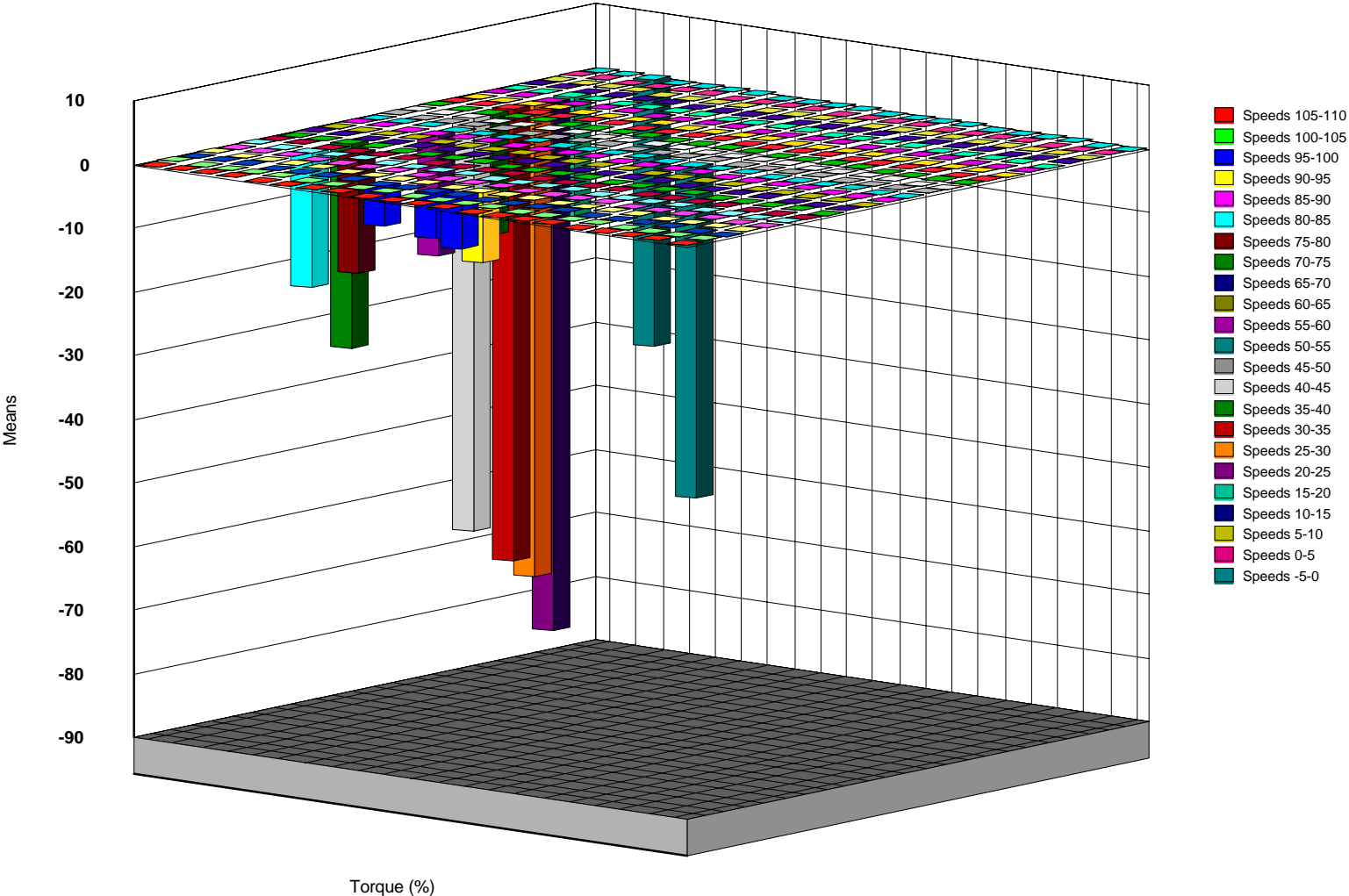
## WELDER TYPICAL 2--Speed Deceleration Counts



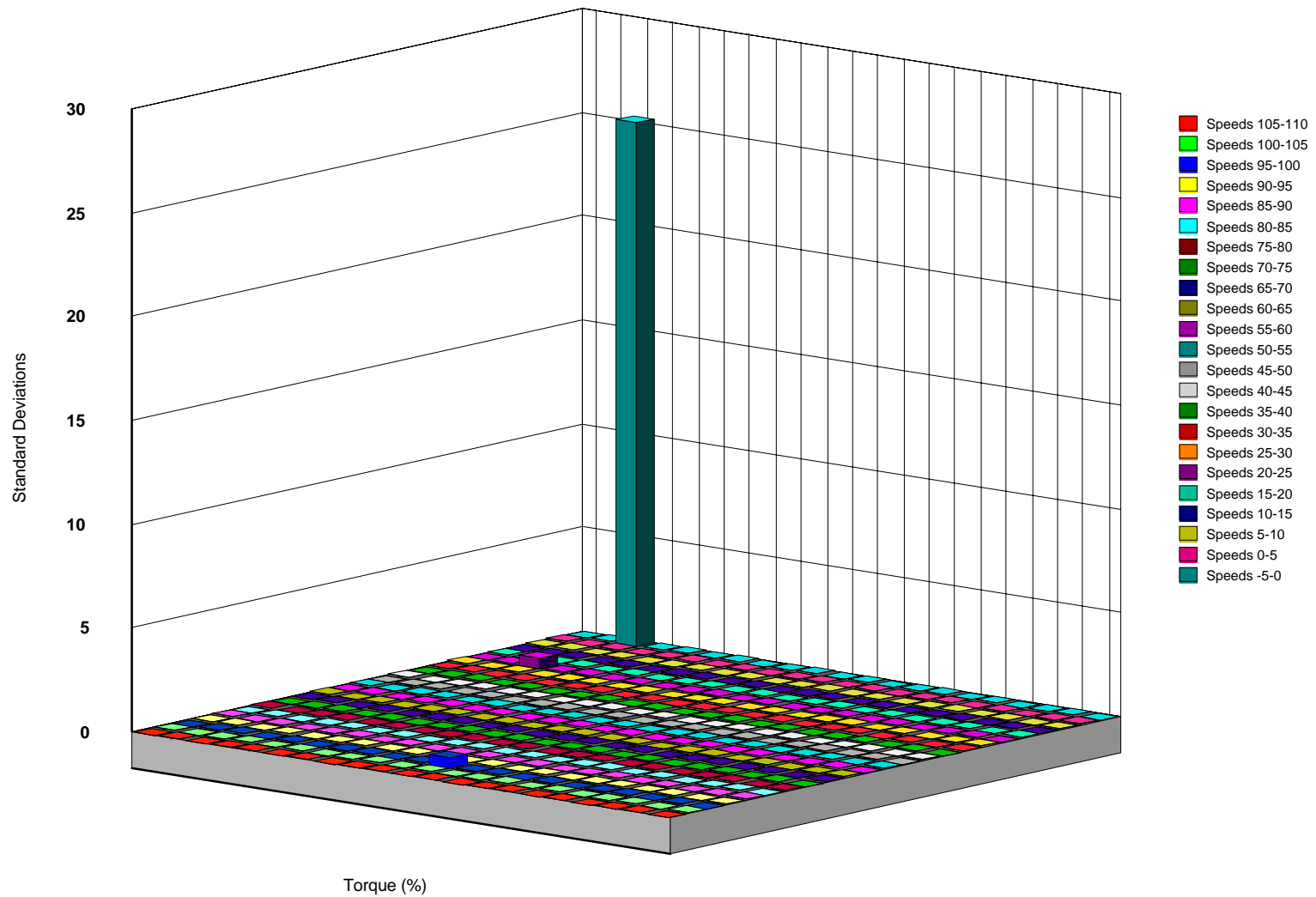
WELDER TYPICAL 2--Speed Deceleration Sums



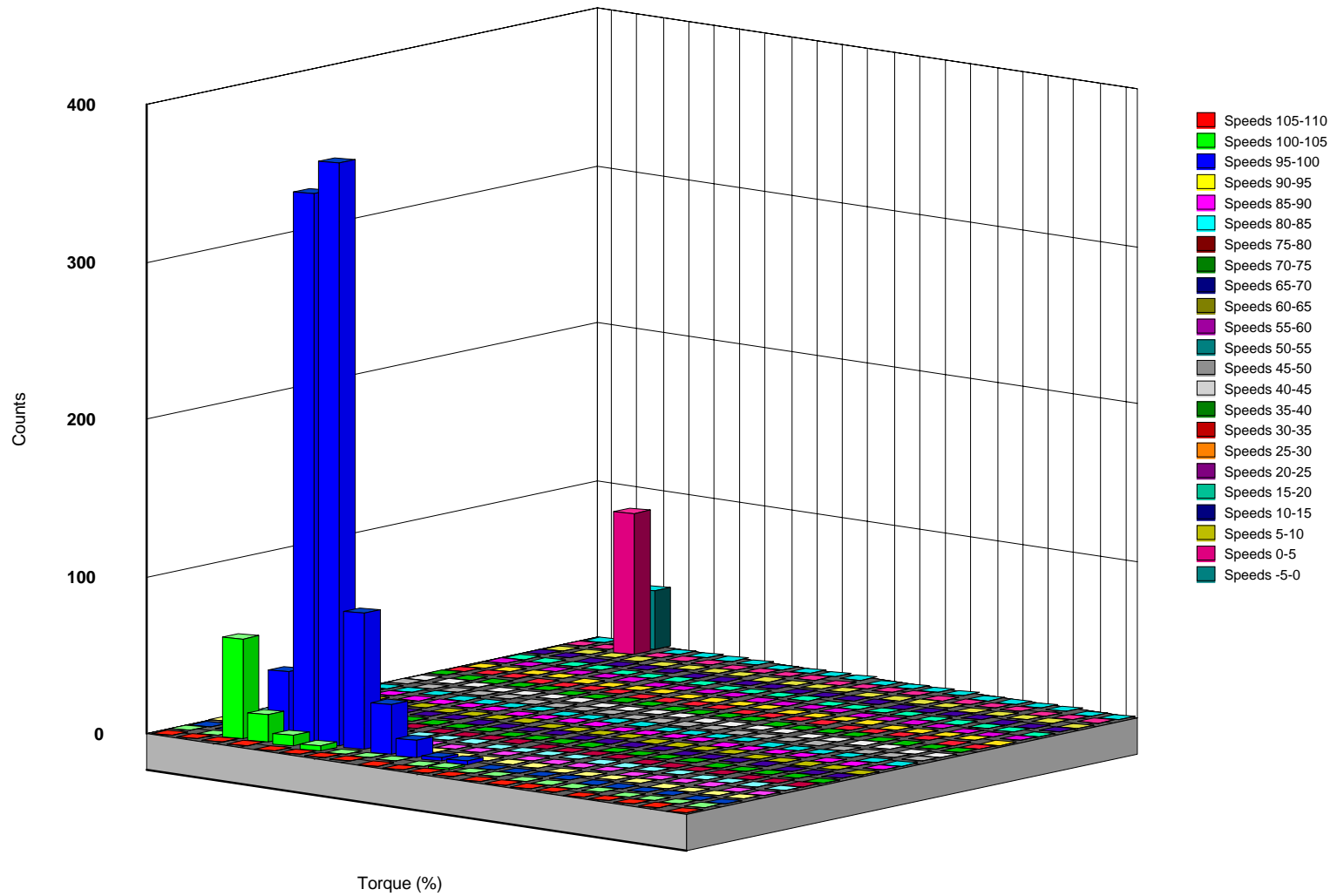
WELDER TYPICAL 2--Speed Deceleration Means



## WELDER TYPICAL 2--Speed Deceleration Standard Deviations

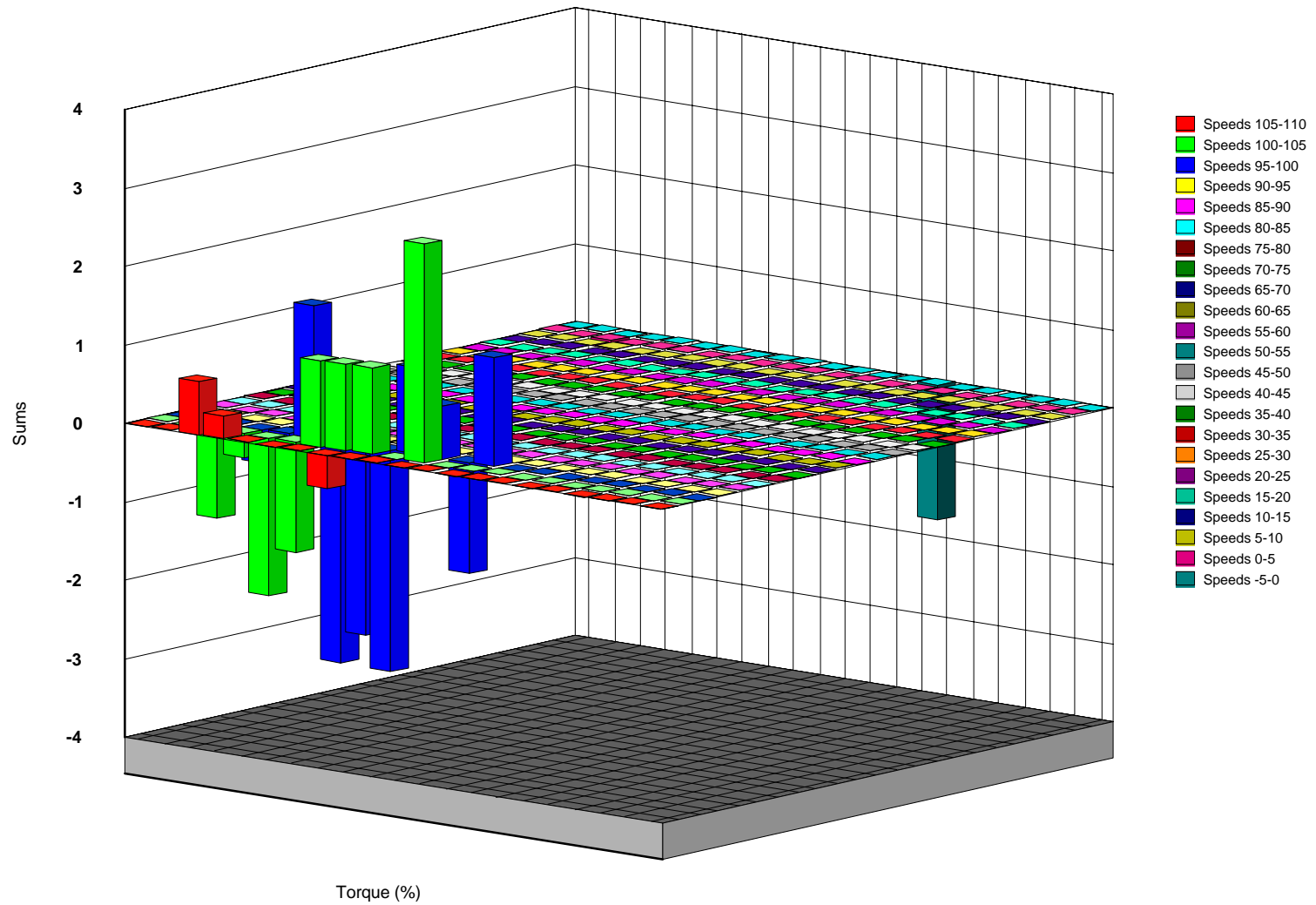


## WELDER TYPICAL 2--Speed Steady State Counts

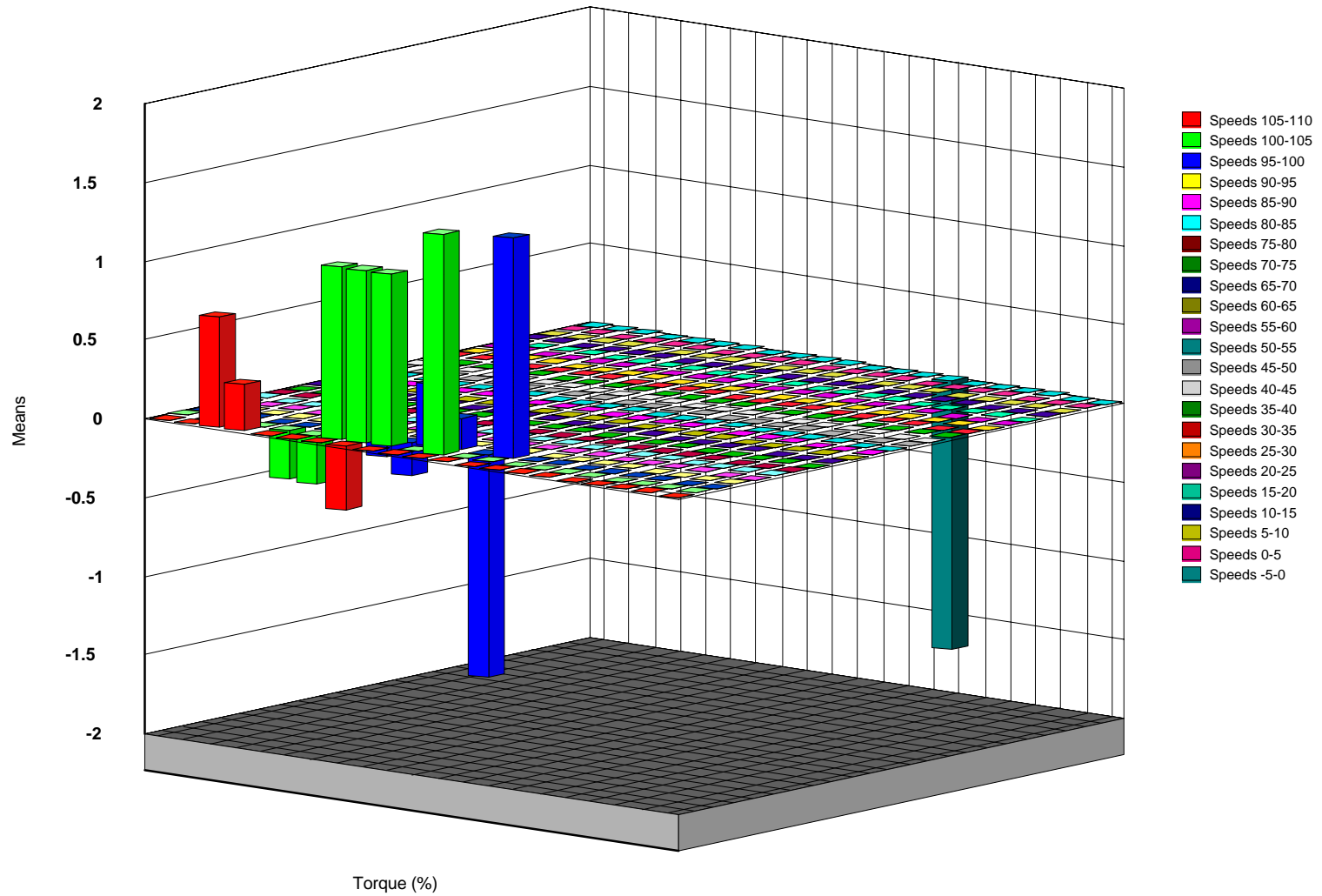




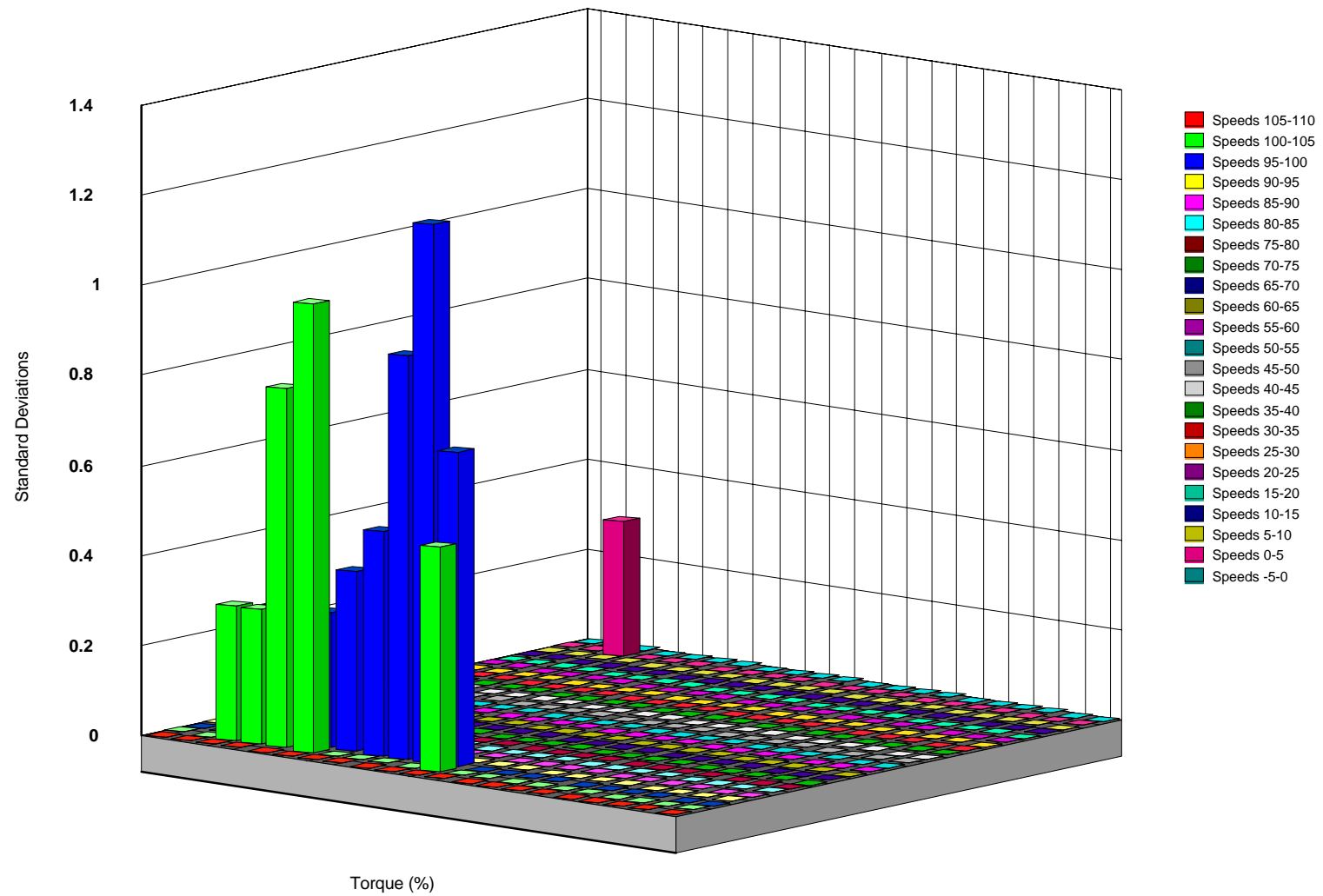
## WELDER TYPICAL 2--Speed Steady State Sums



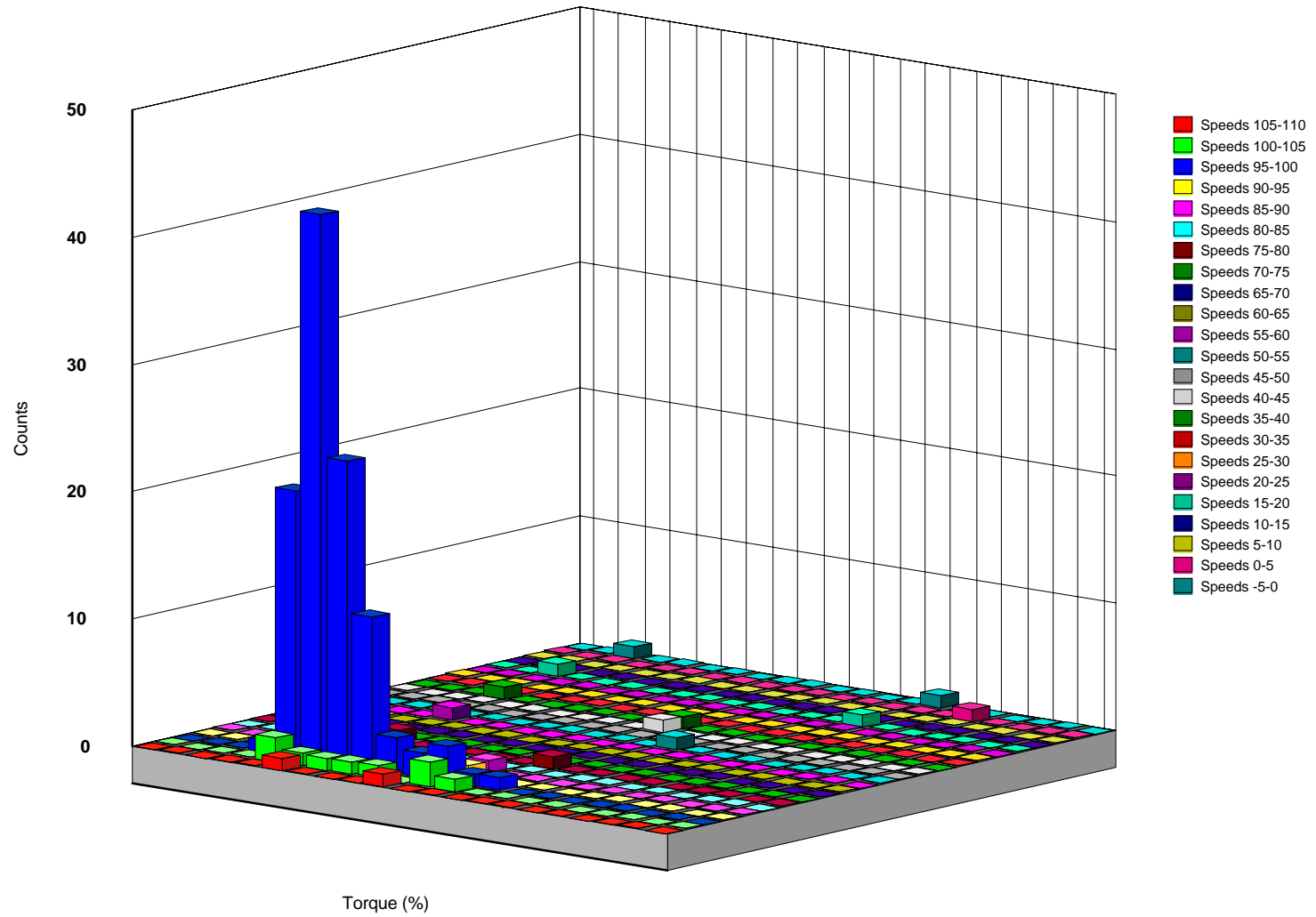
## WELDER TYPICAL 2--Speed Steady State Means



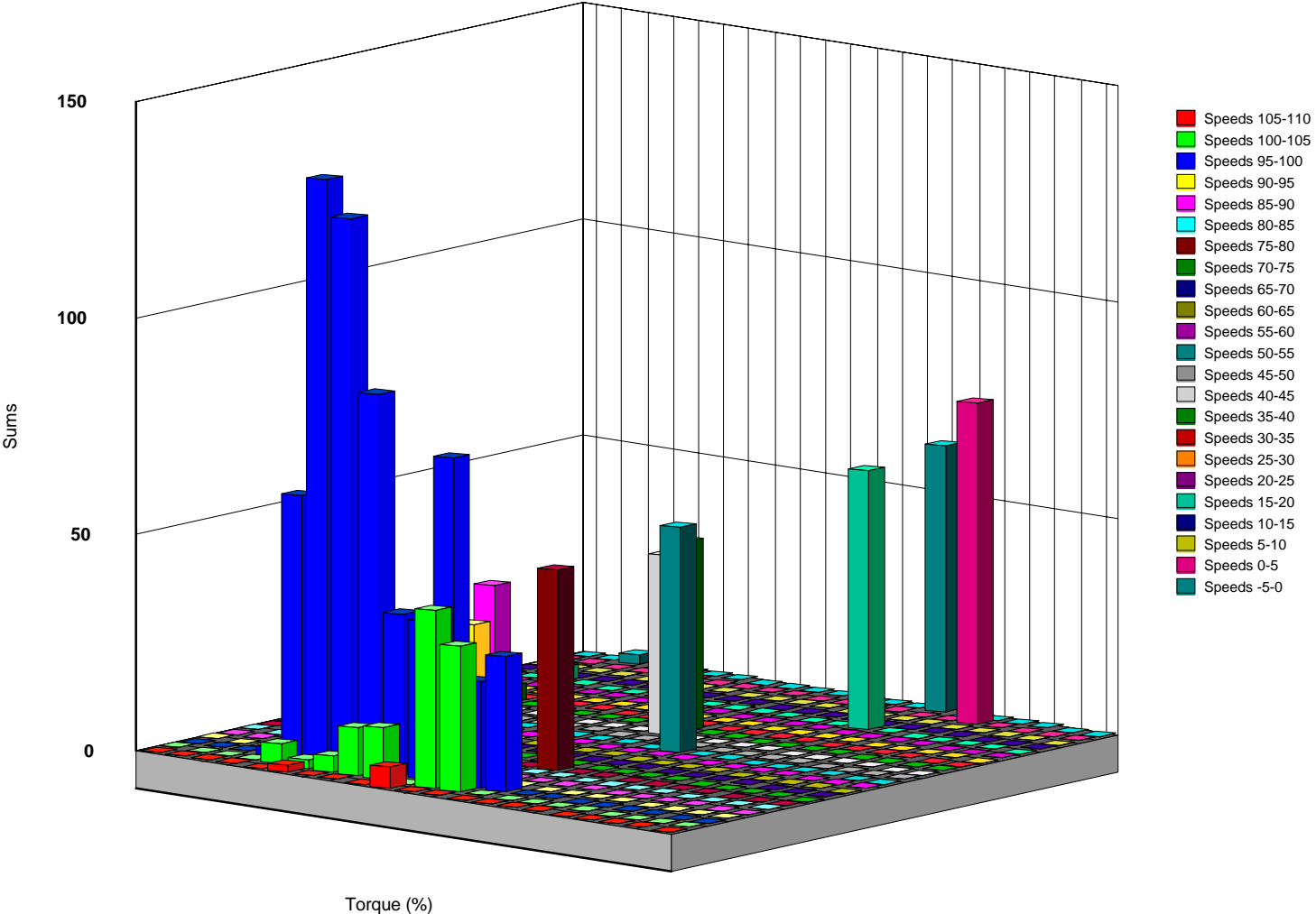
## WELDER TYPICAL 2--Speed Steady State Standard Deviations



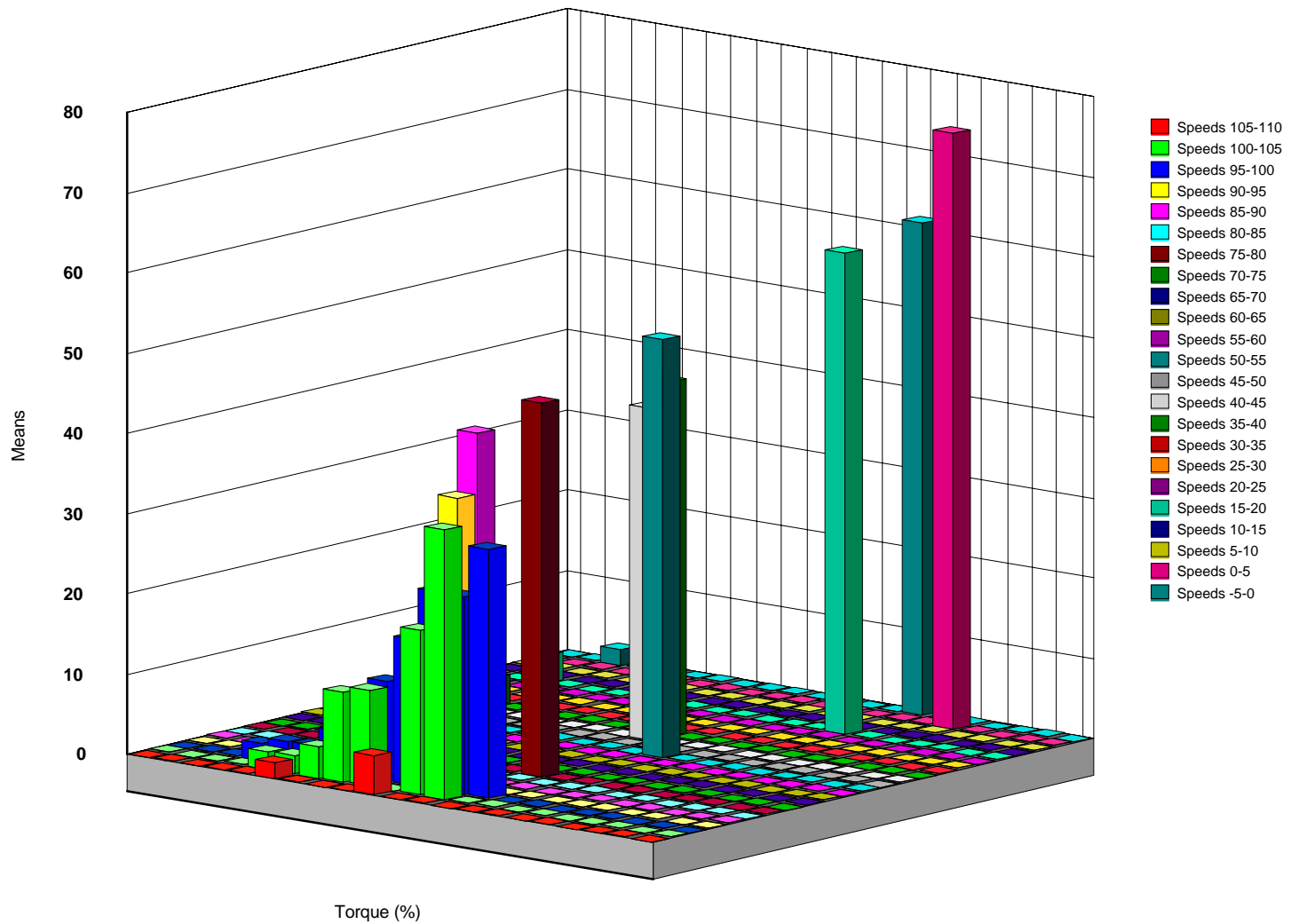
## WELDER TYPICAL 2--Torque Acceleration Counts



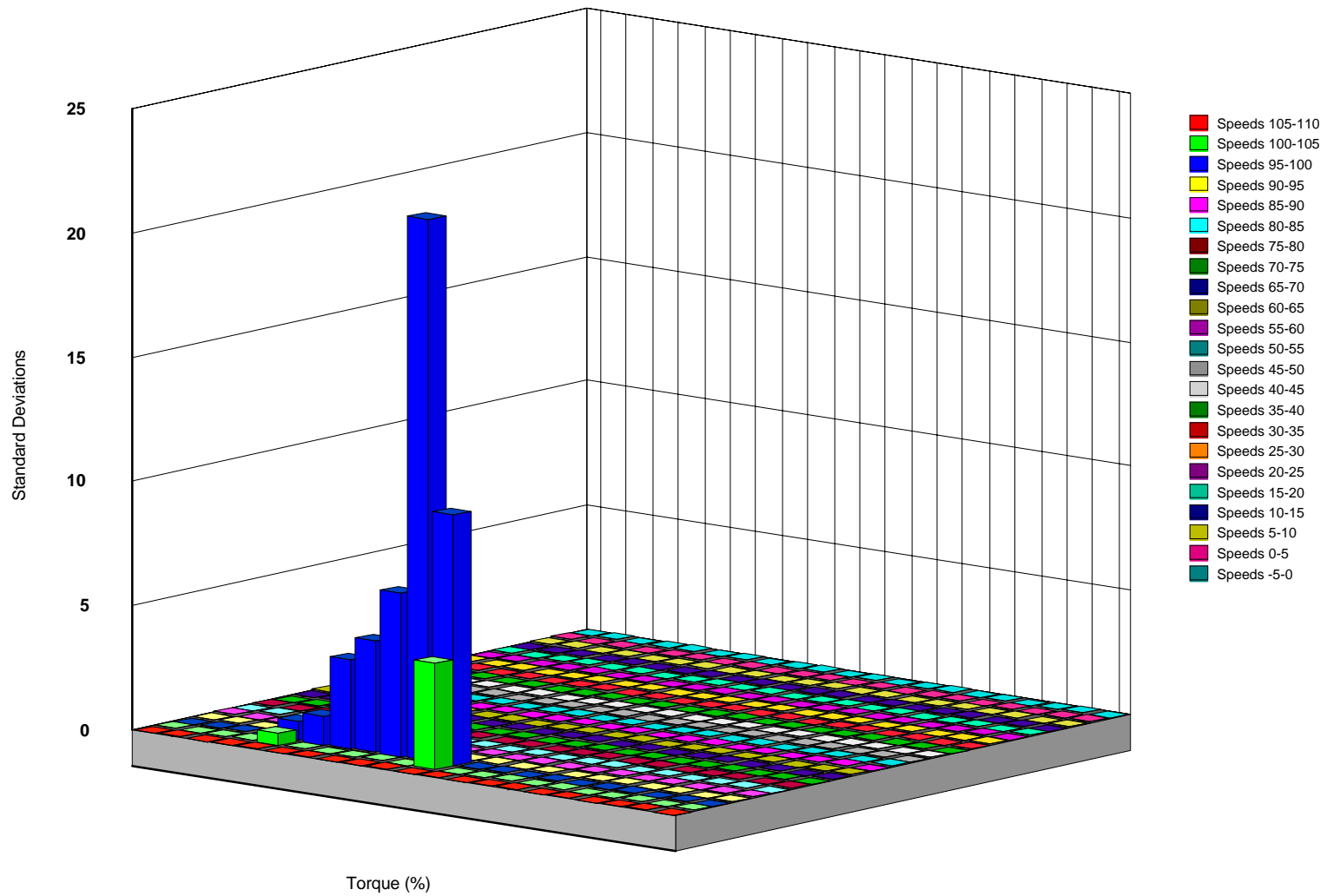
WELDER TYPICAL 2--Torque Acceleration Sums



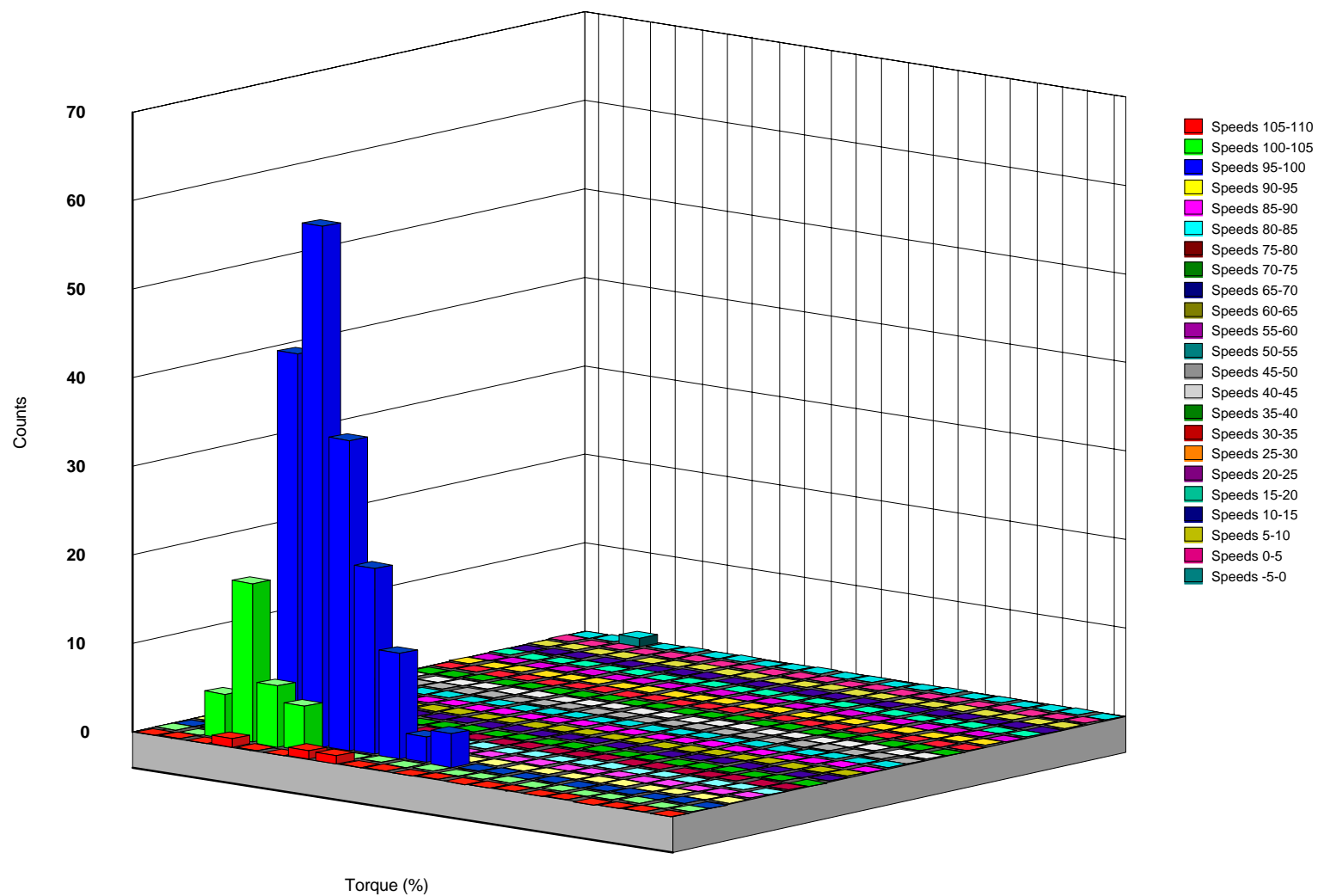
## WELDER TYPICAL 2--Torque Acceleration Means



## WELDER TYPICAL 2--Torque Acceleration Standard Deviations

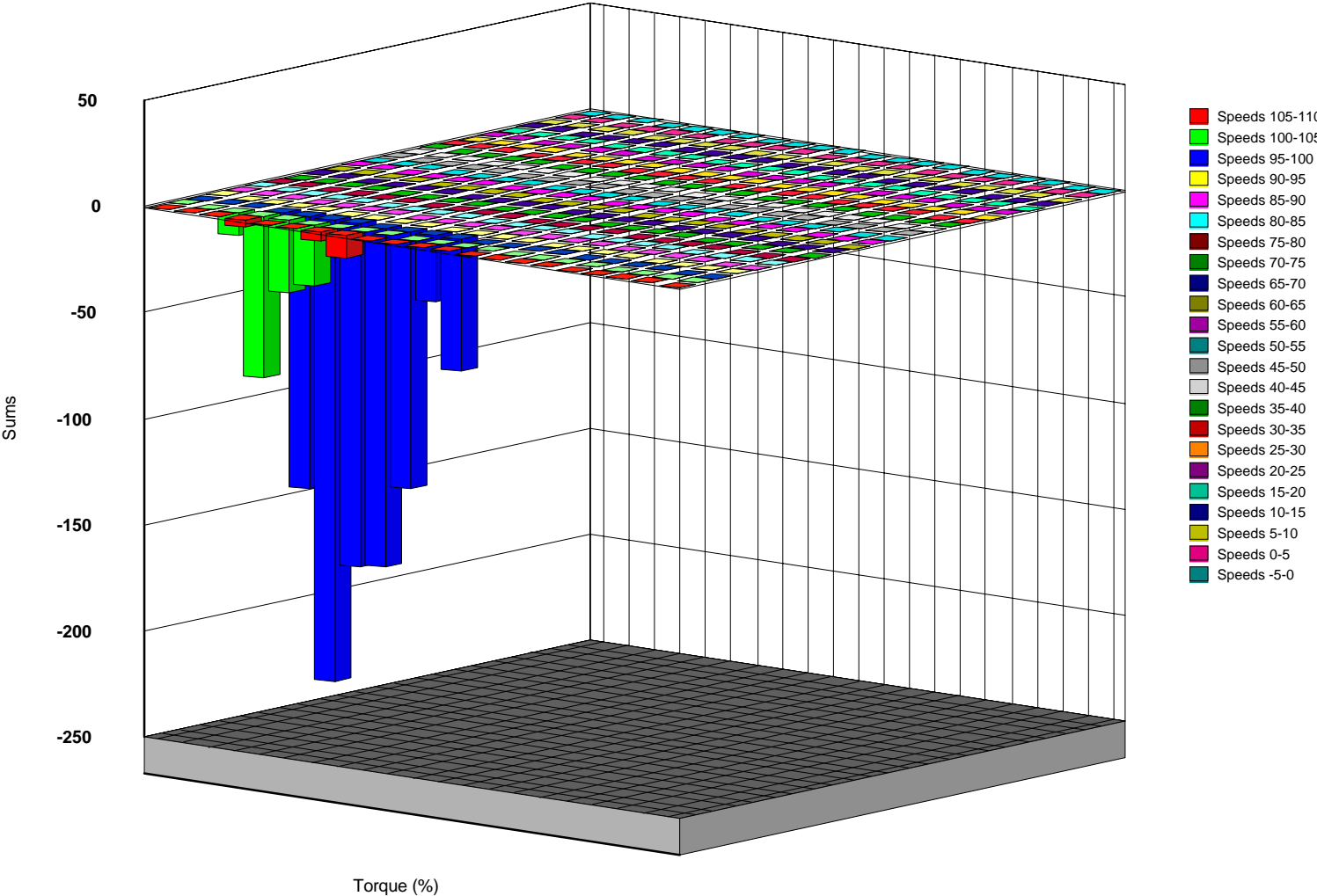


## WELDER TYPICAL 2--Torque Deceleration Counts

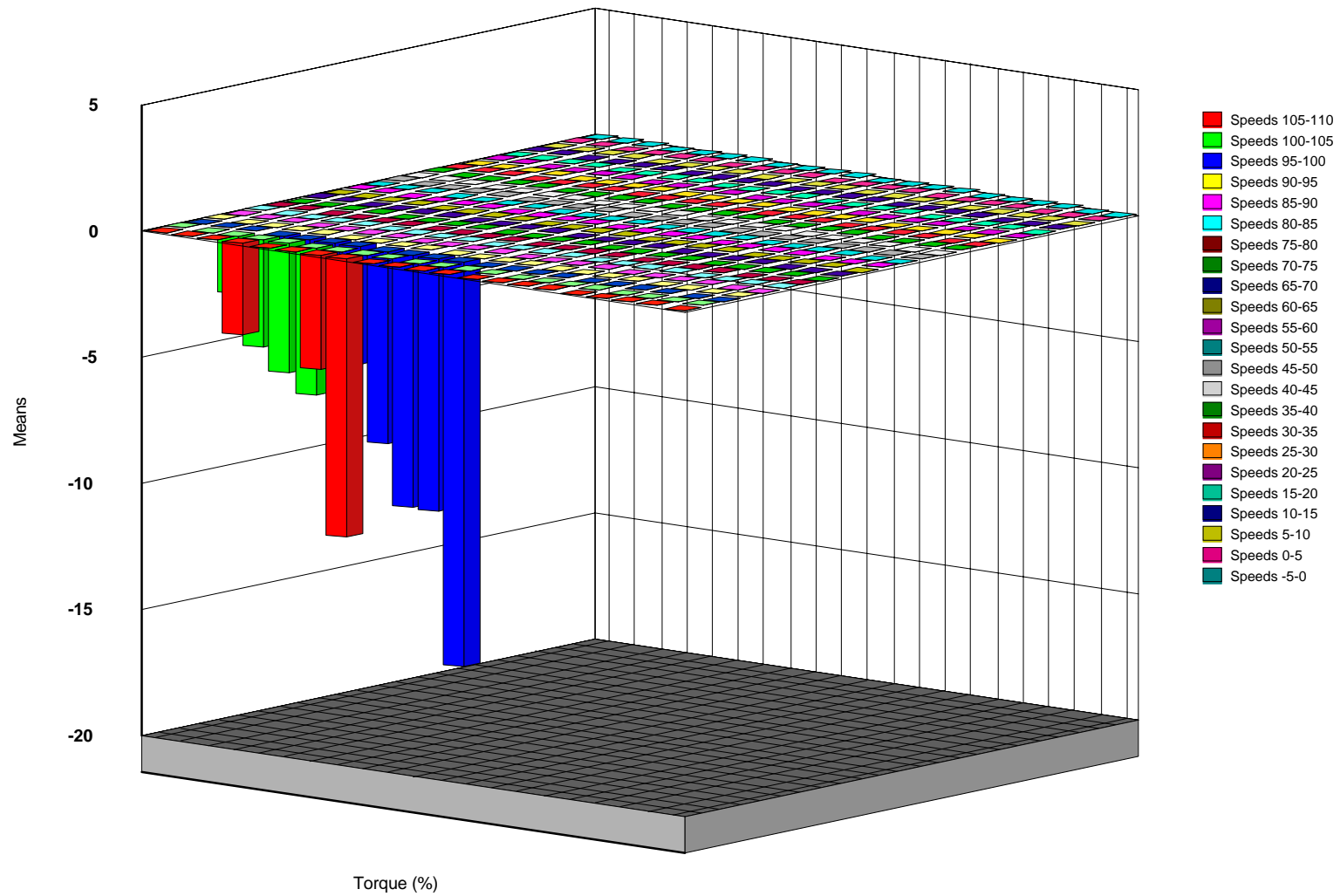




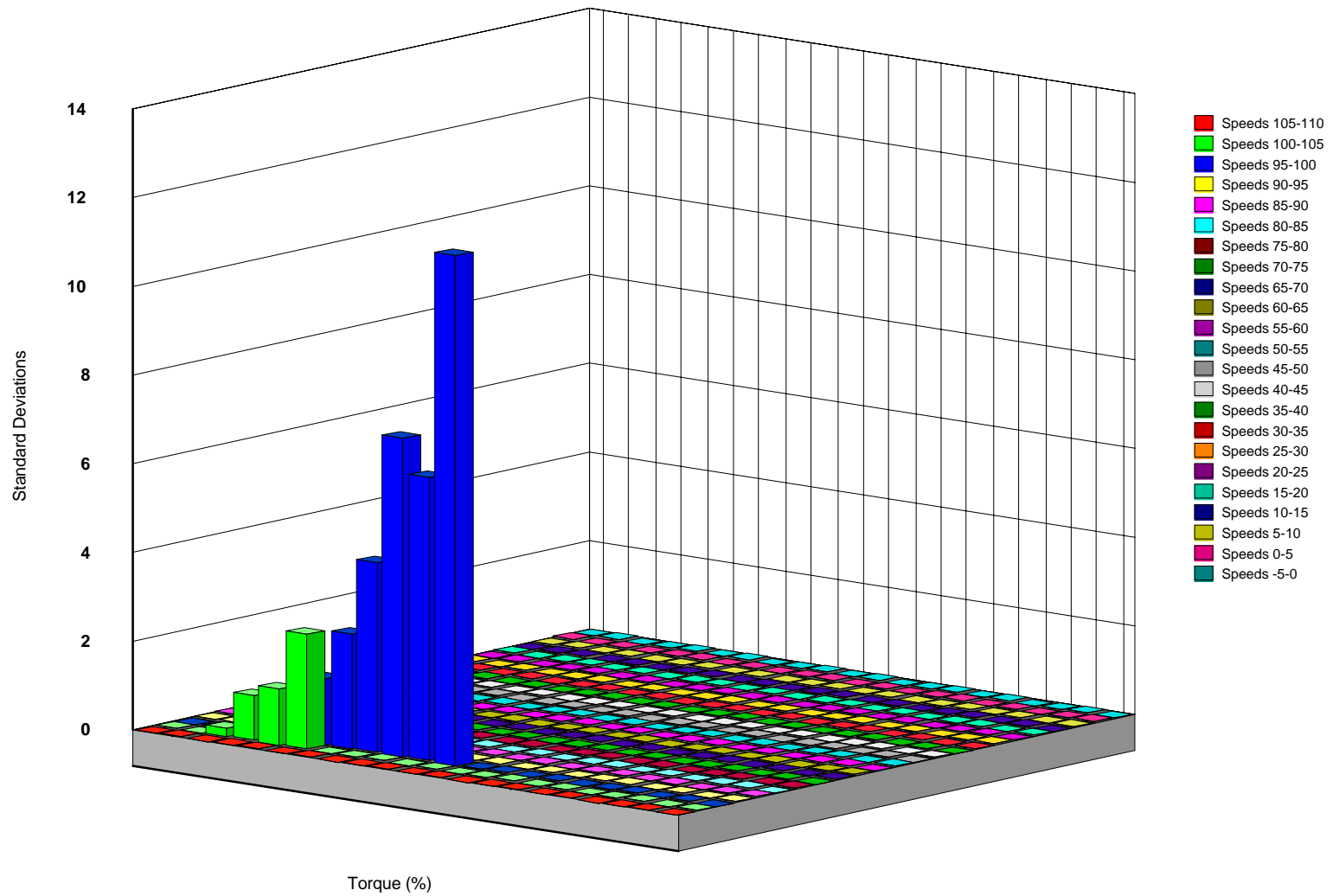
WELDER TYPICAL 2--Torque Deceleration Sums



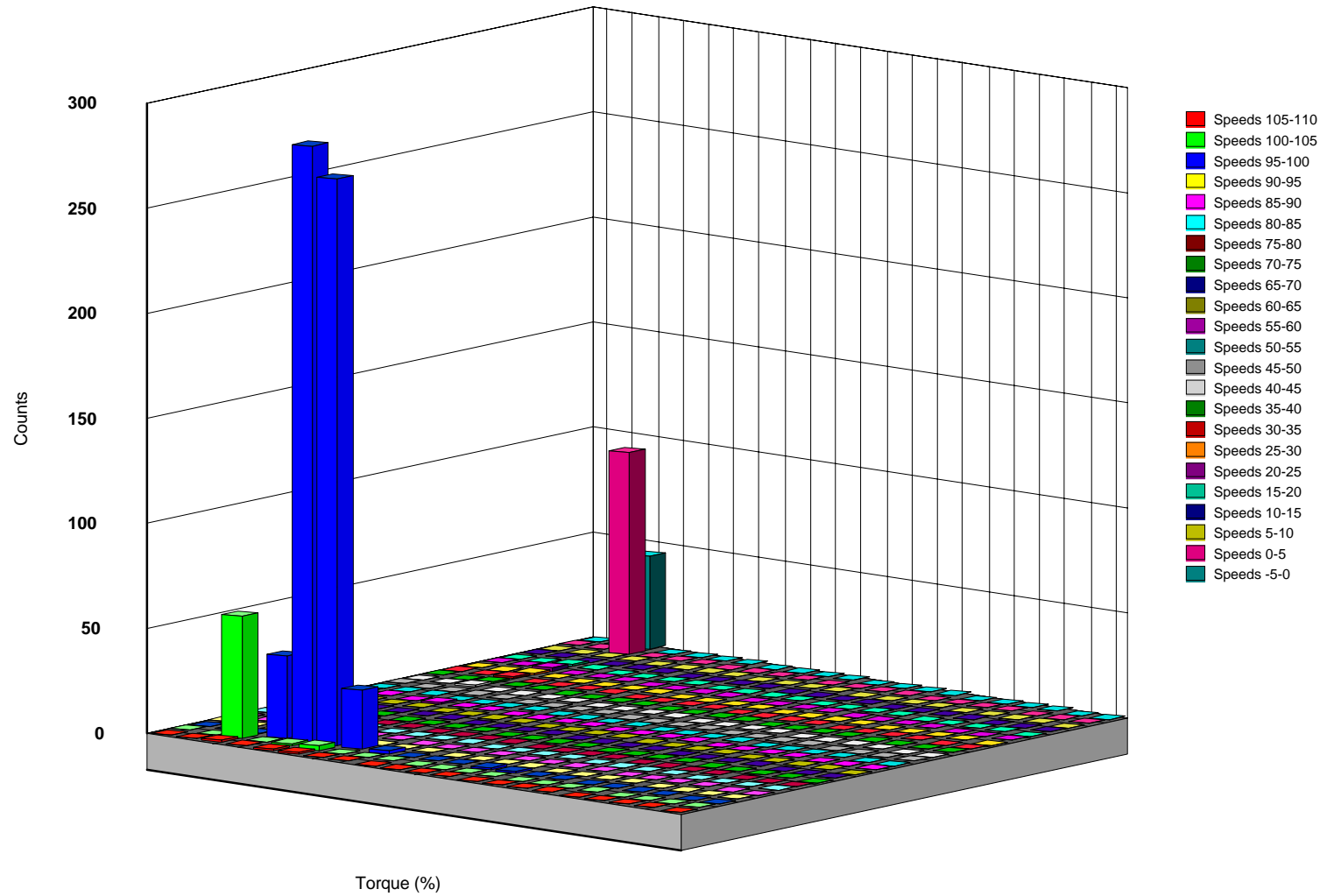
## WELDER TYPICAL 2--Torque Deceleration Means



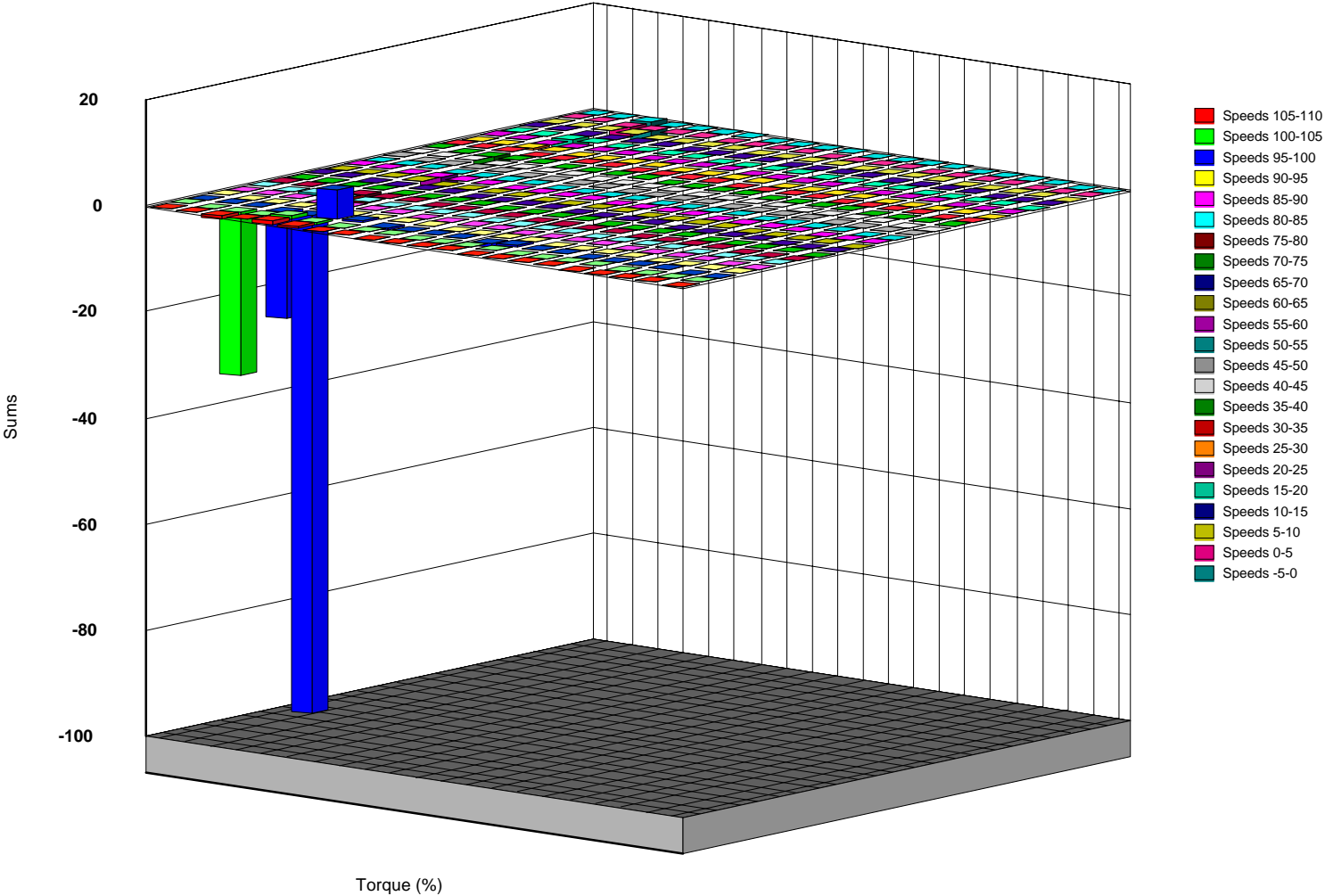
## WELDER TYPICAL 2--Torque Deceleration Standard Deviations



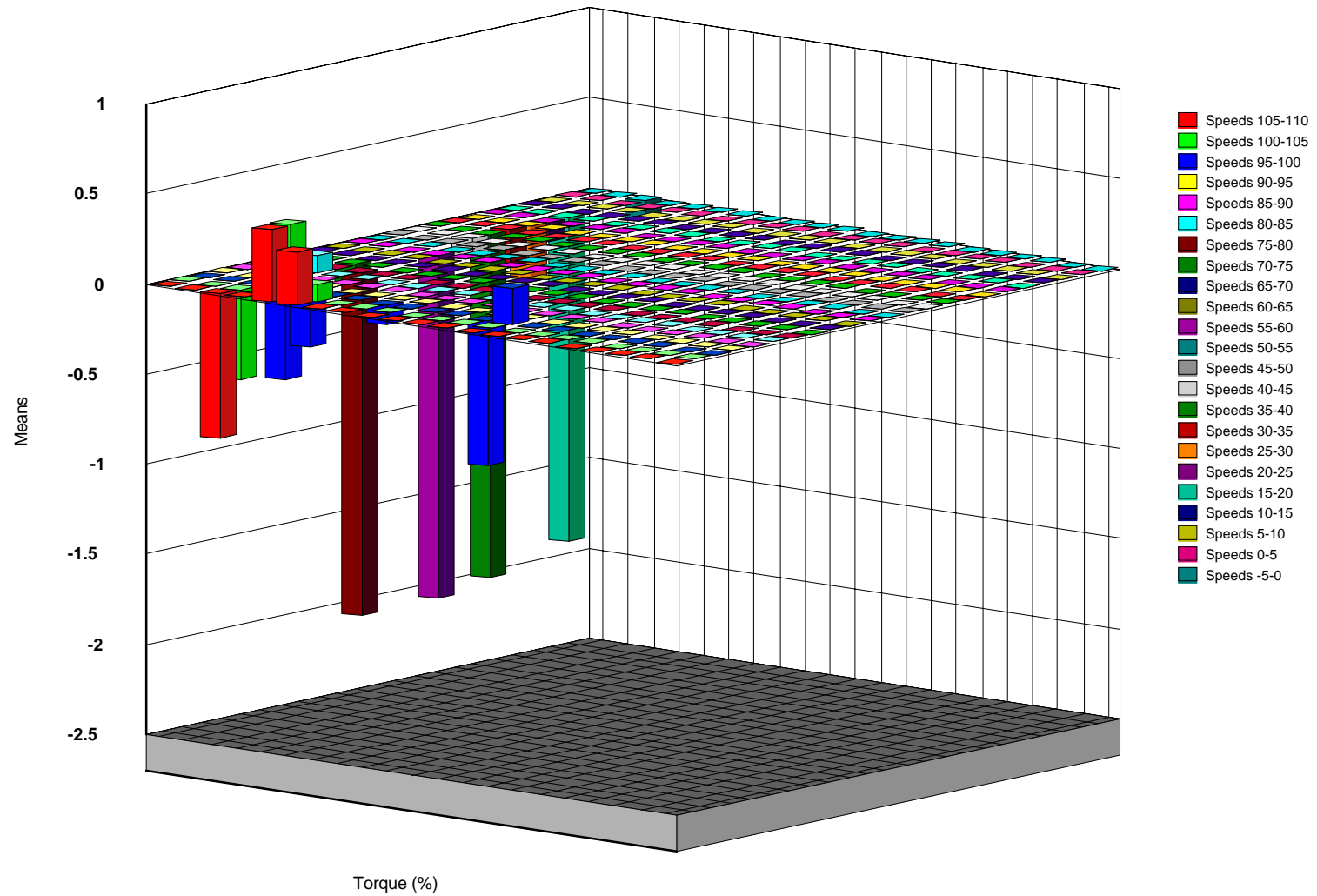
## WELDER TYPICAL 2--Torque Steady State Counts



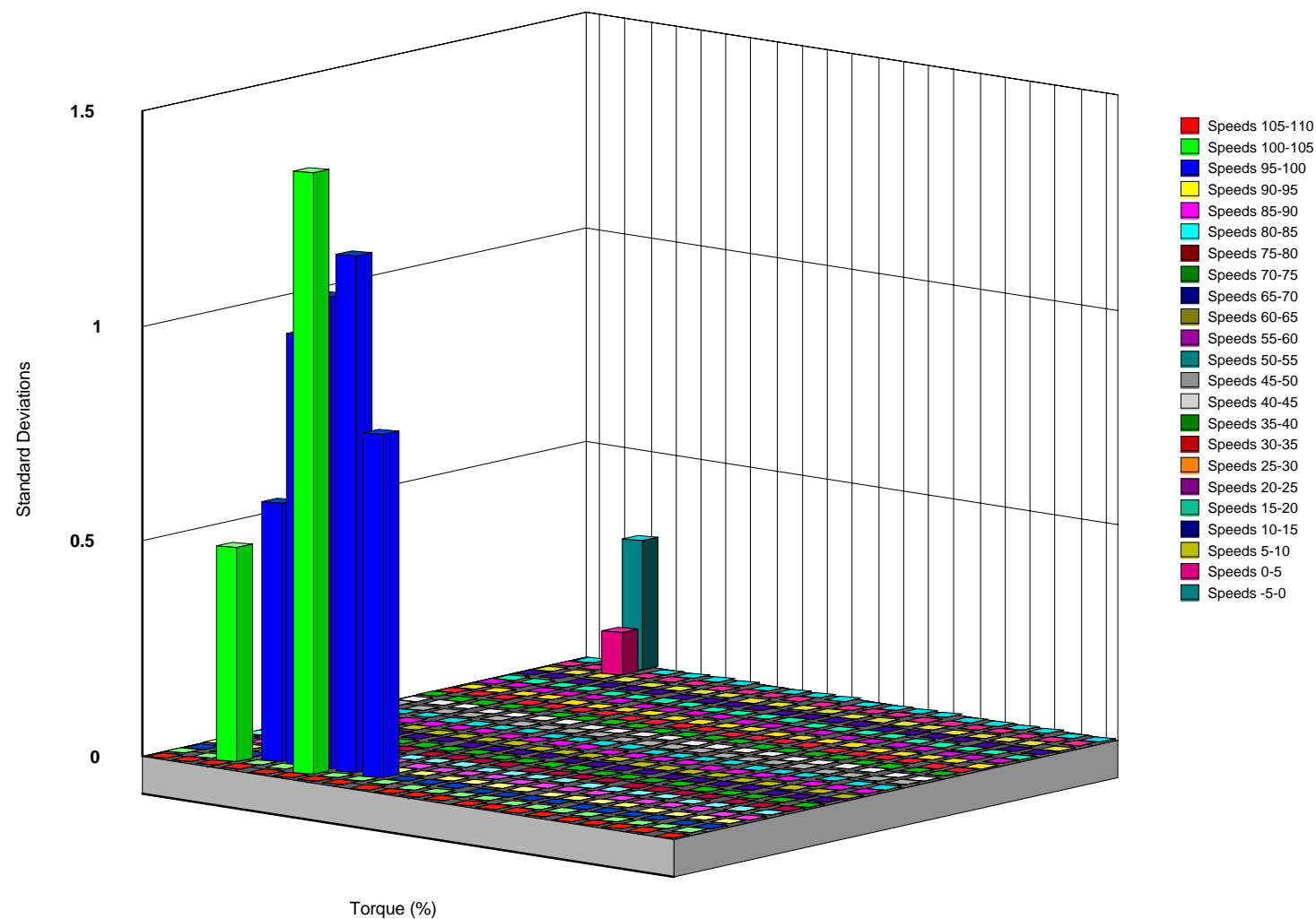
WELDER TYPICAL 2--Torque Steady State Sums



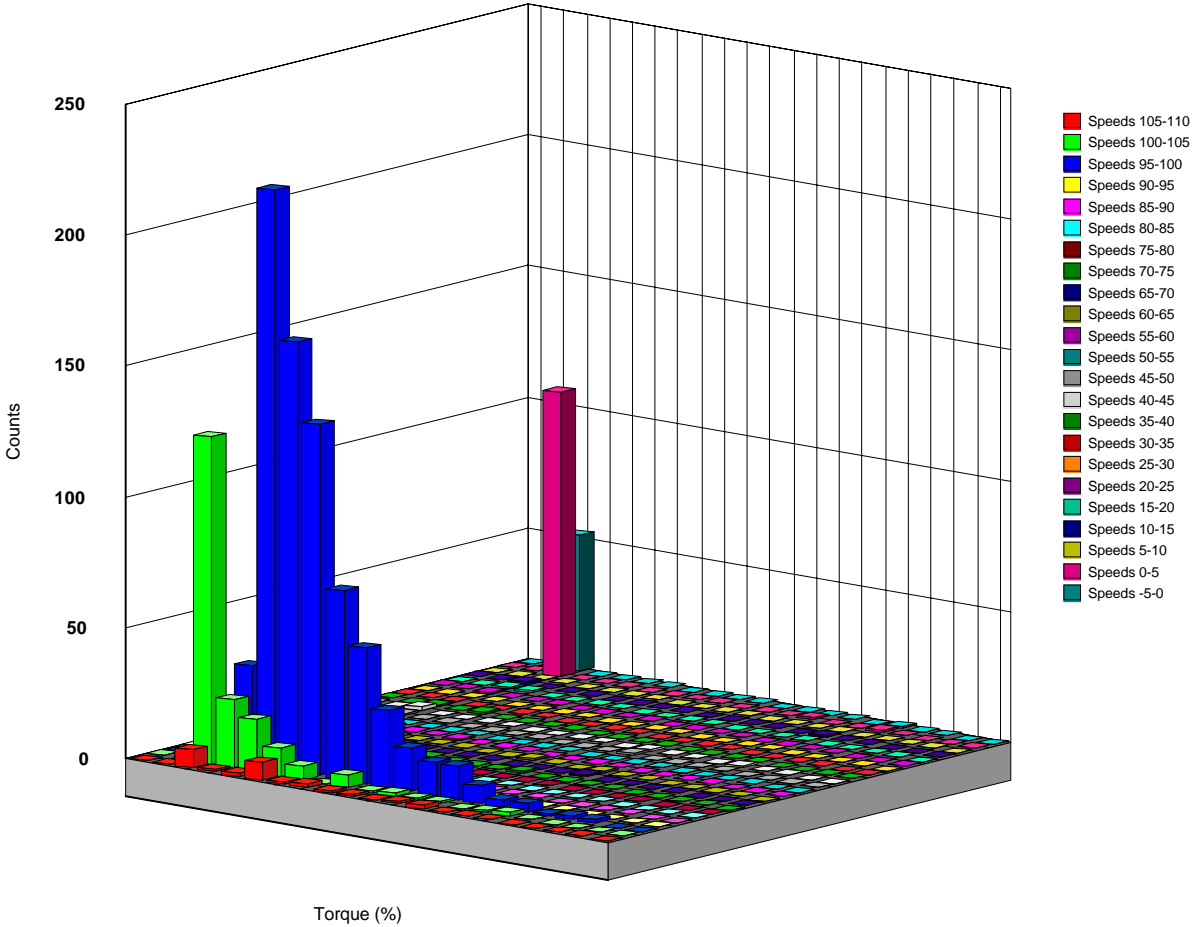
## WELDER TYPICAL 2--Torque Steady State Means



WELDER TYPICAL 2--Torque Steady State Standard Deviations

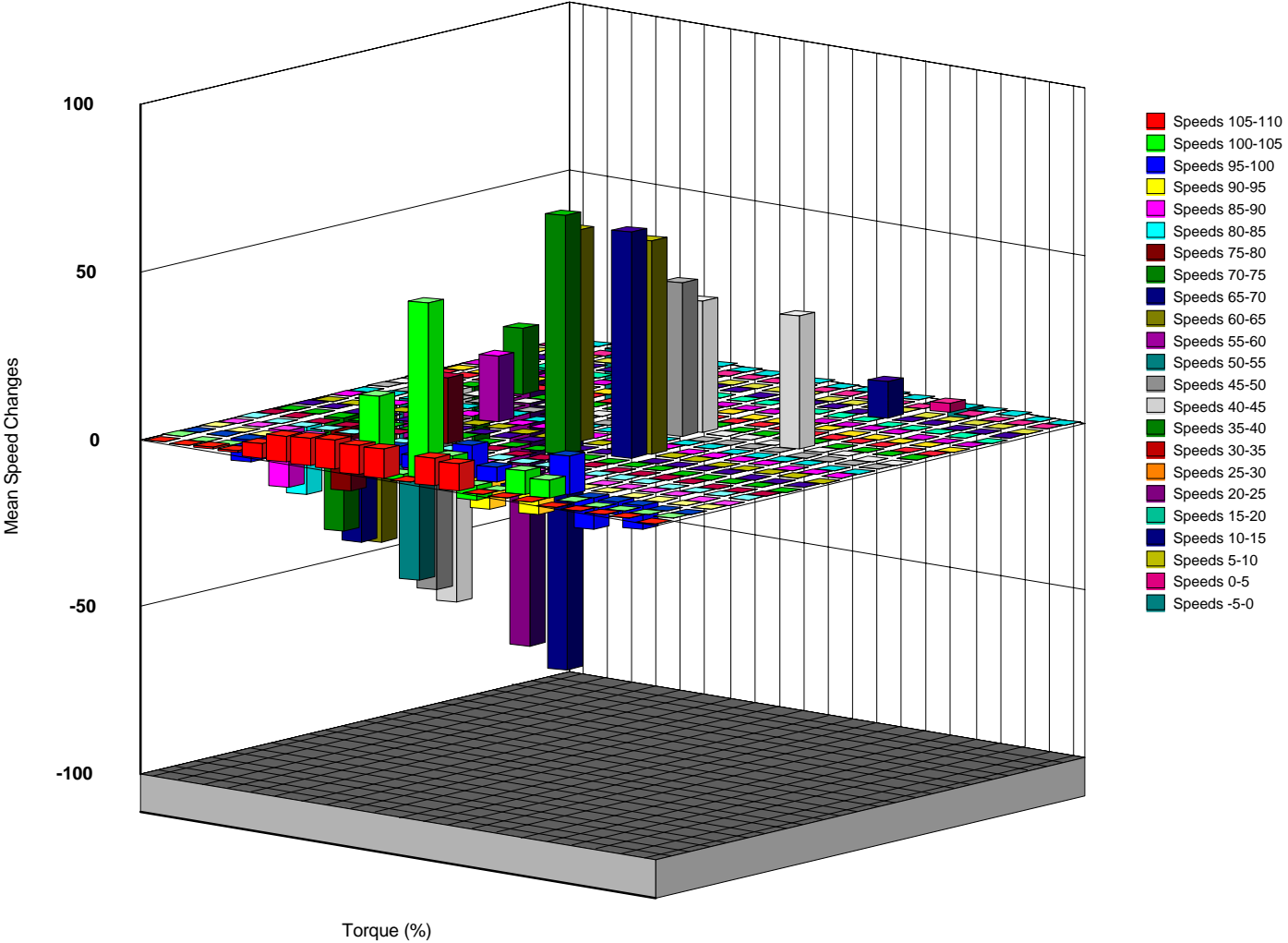


## WELDER HIGH SPEED TRANSIENT--Counts

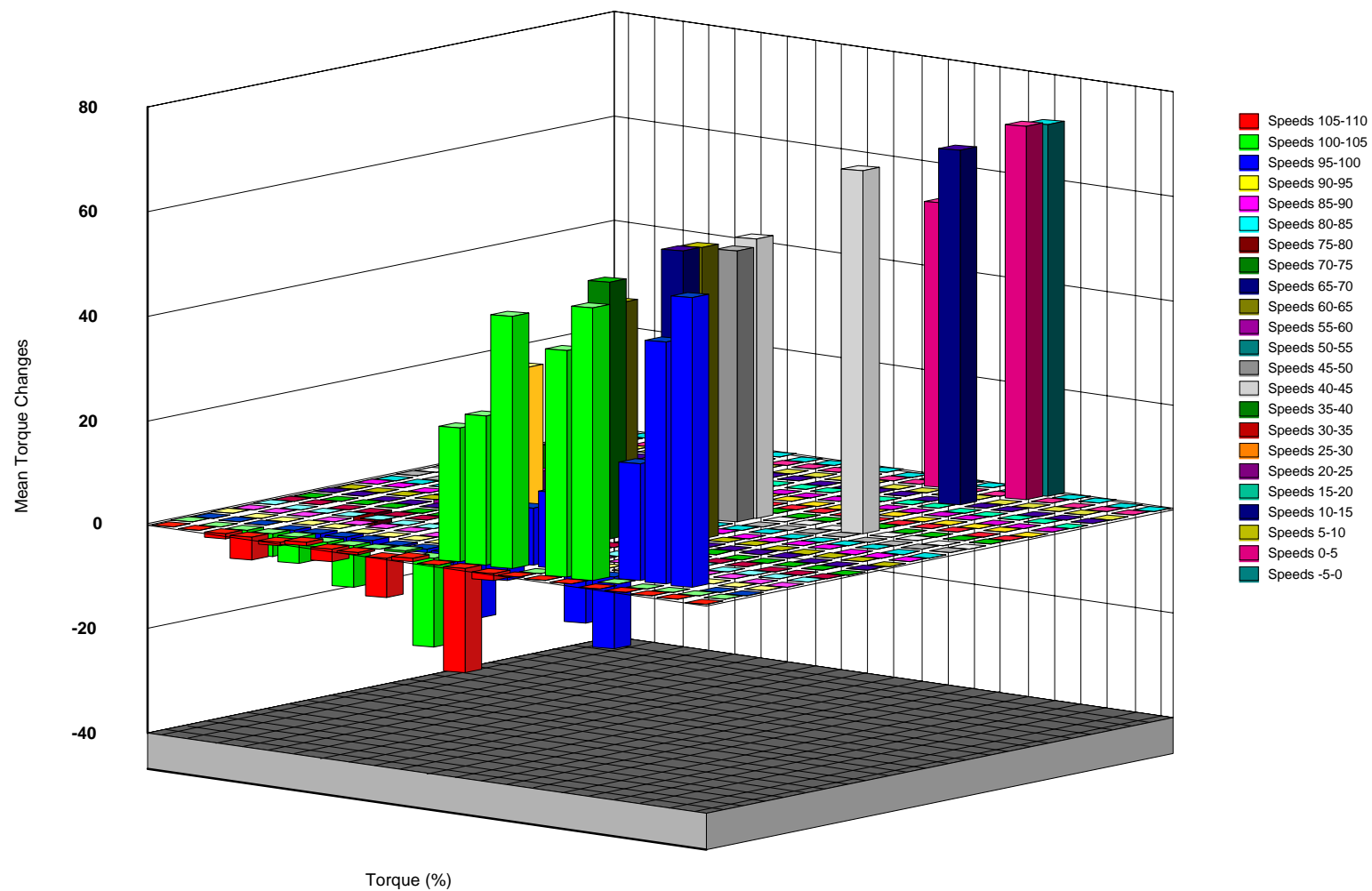




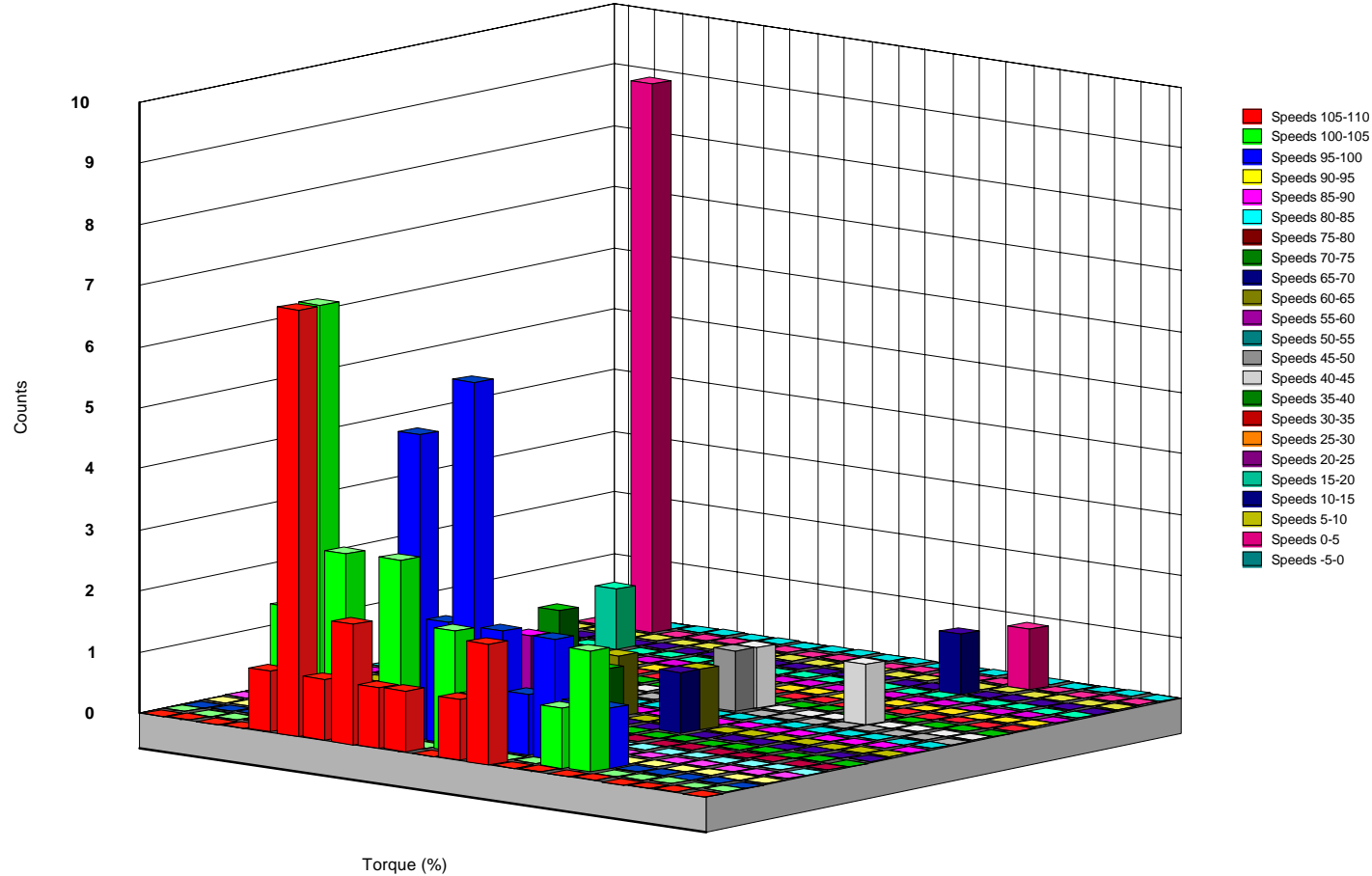
WELDER HIGH SPEED TRANSIENT--Mean Speed Changes



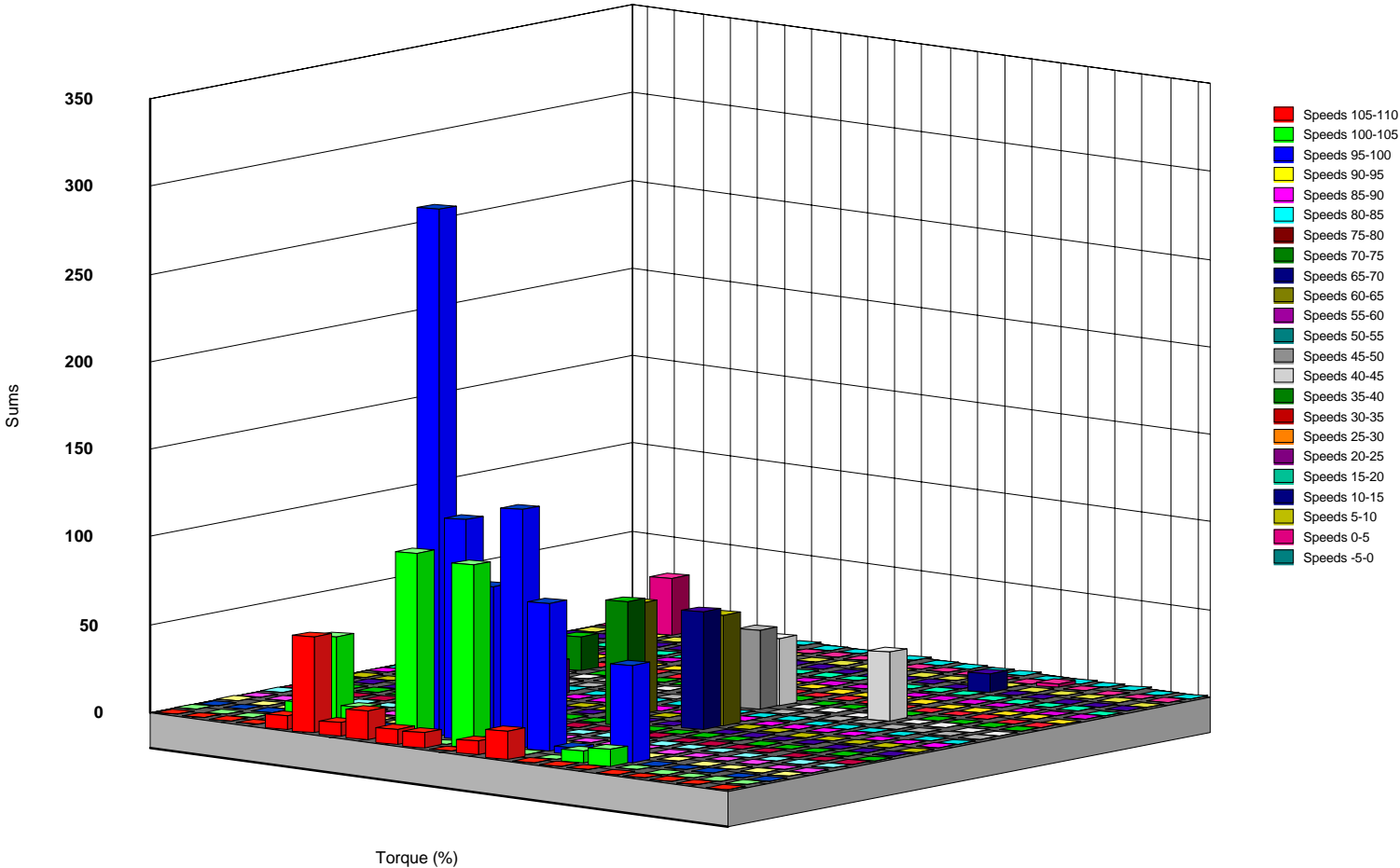
## WELDER HIGH SPEED TRANSIENT--Mean Torque Changes



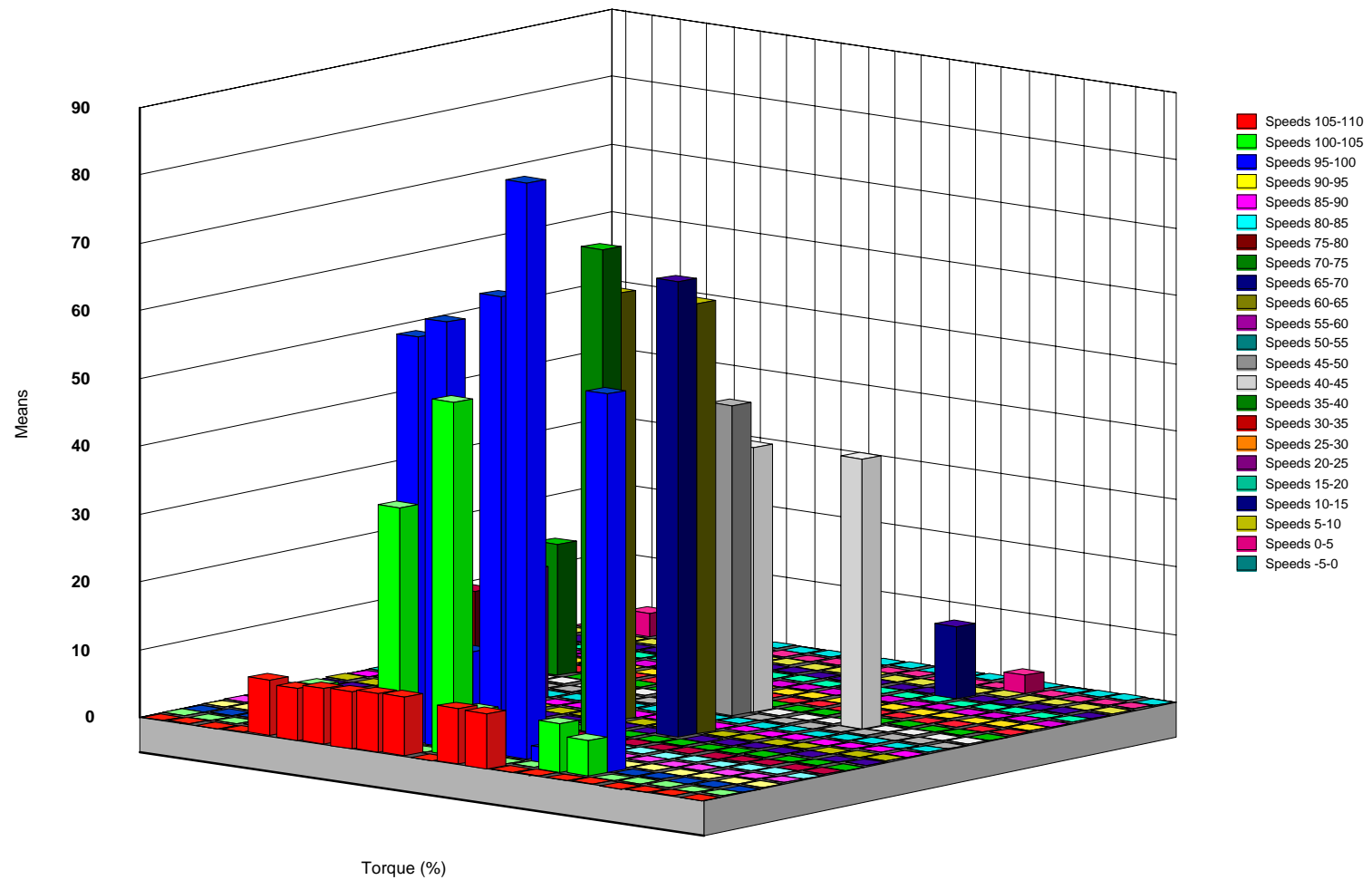
WELDER HIGH SPEED TRANSIENT--Speed Acceleration Counts



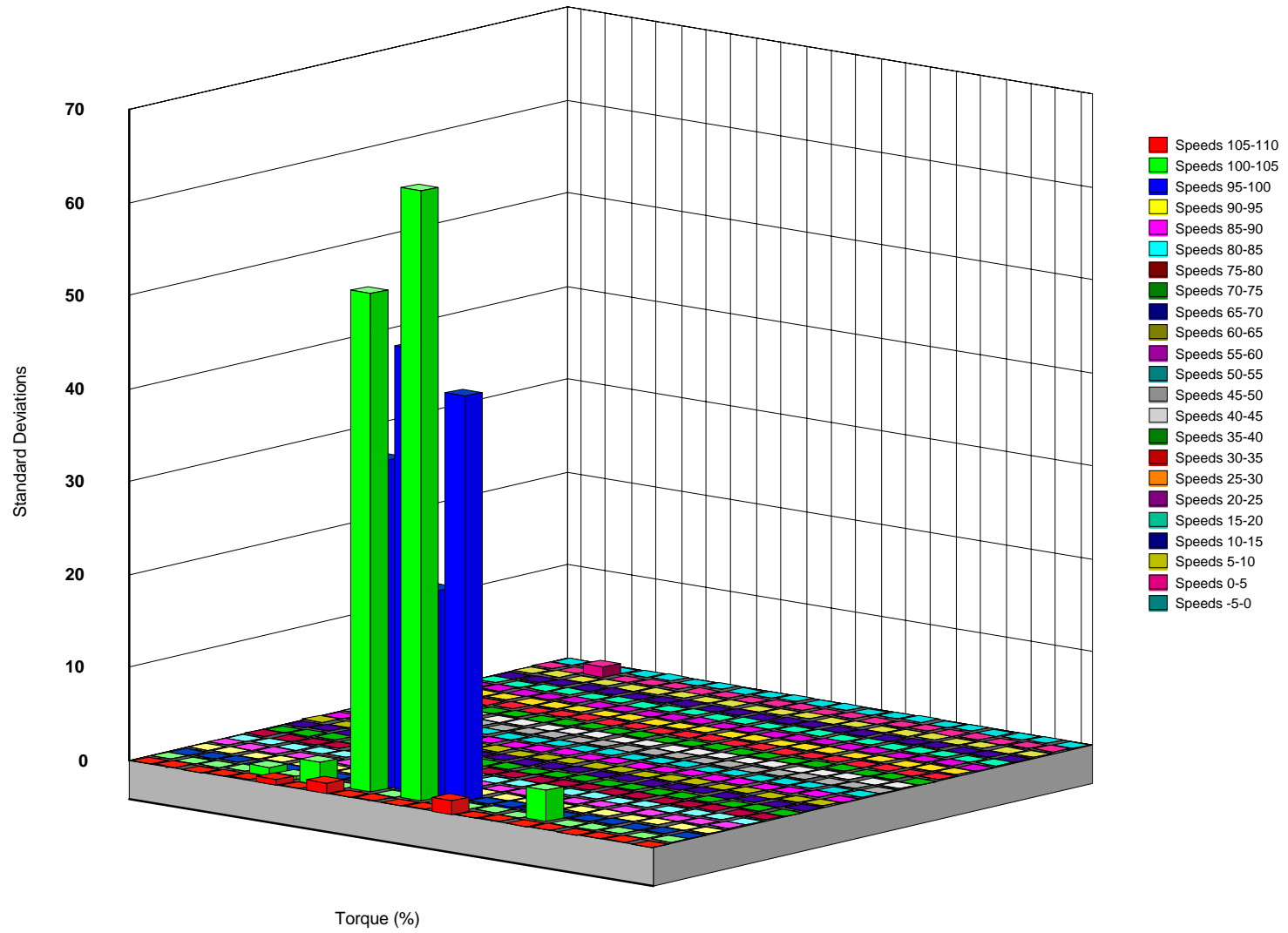
WELDER HIGH SPEED TRANSIENT--Speed Acceleration Sums



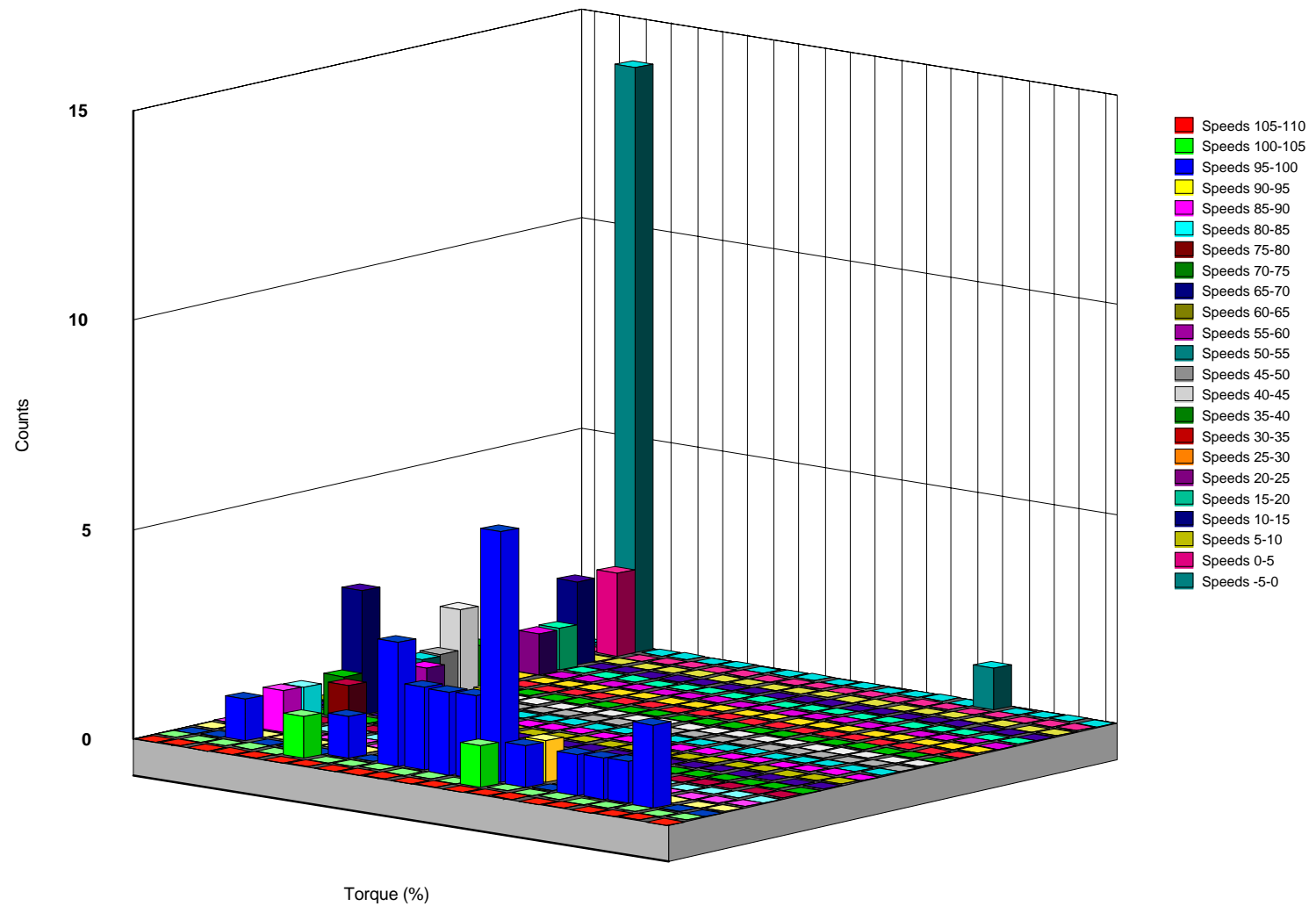
## WELDER HIGH SPEED TRANSIENT--Speed Acceleration Means



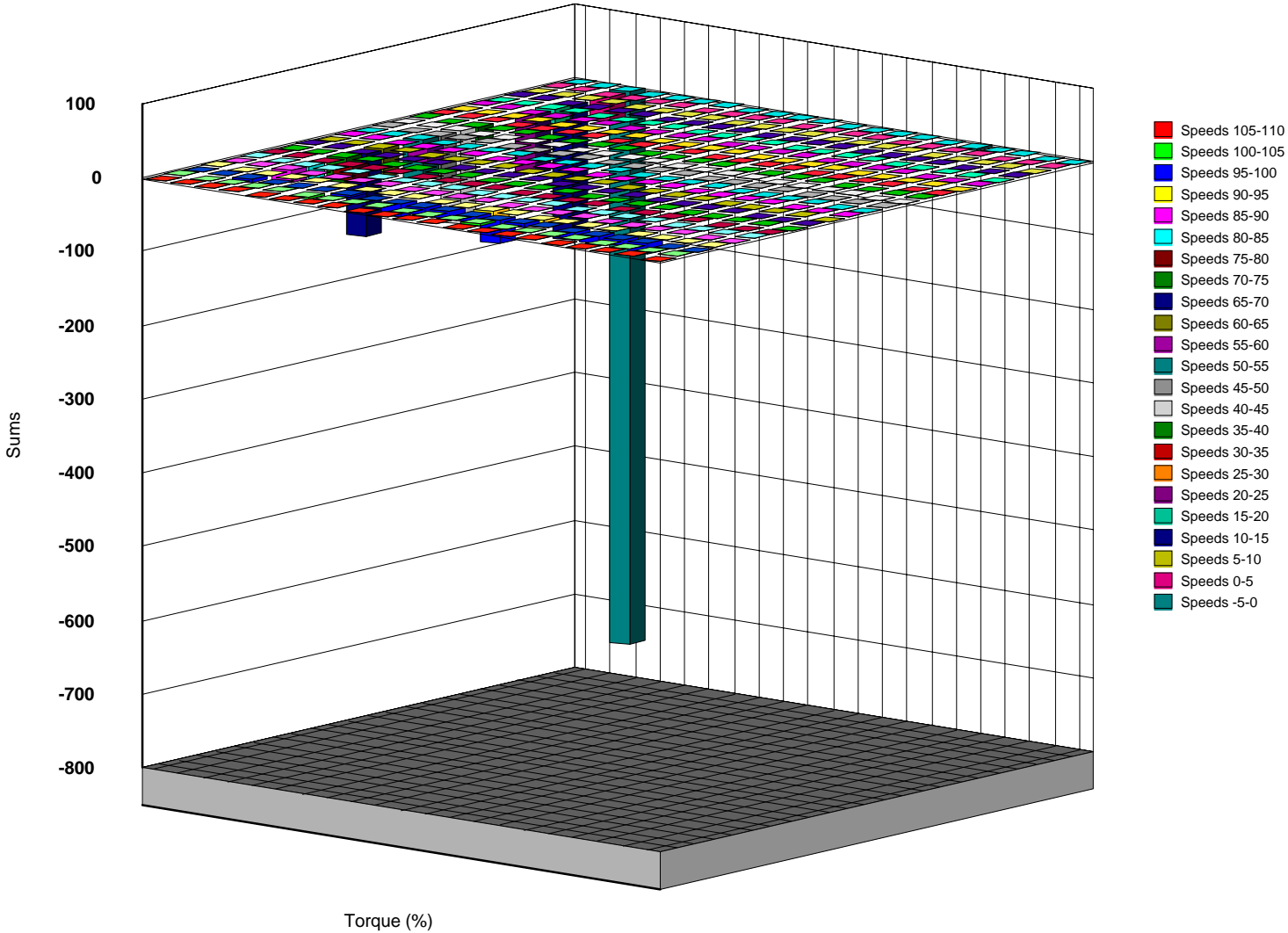
WELDER HIGH SPEED TRANSIENT--Speed Acceleration Standard Deviations



## WELDER HIGH SPEED TRANSIENT--Speed Deceleration Counts

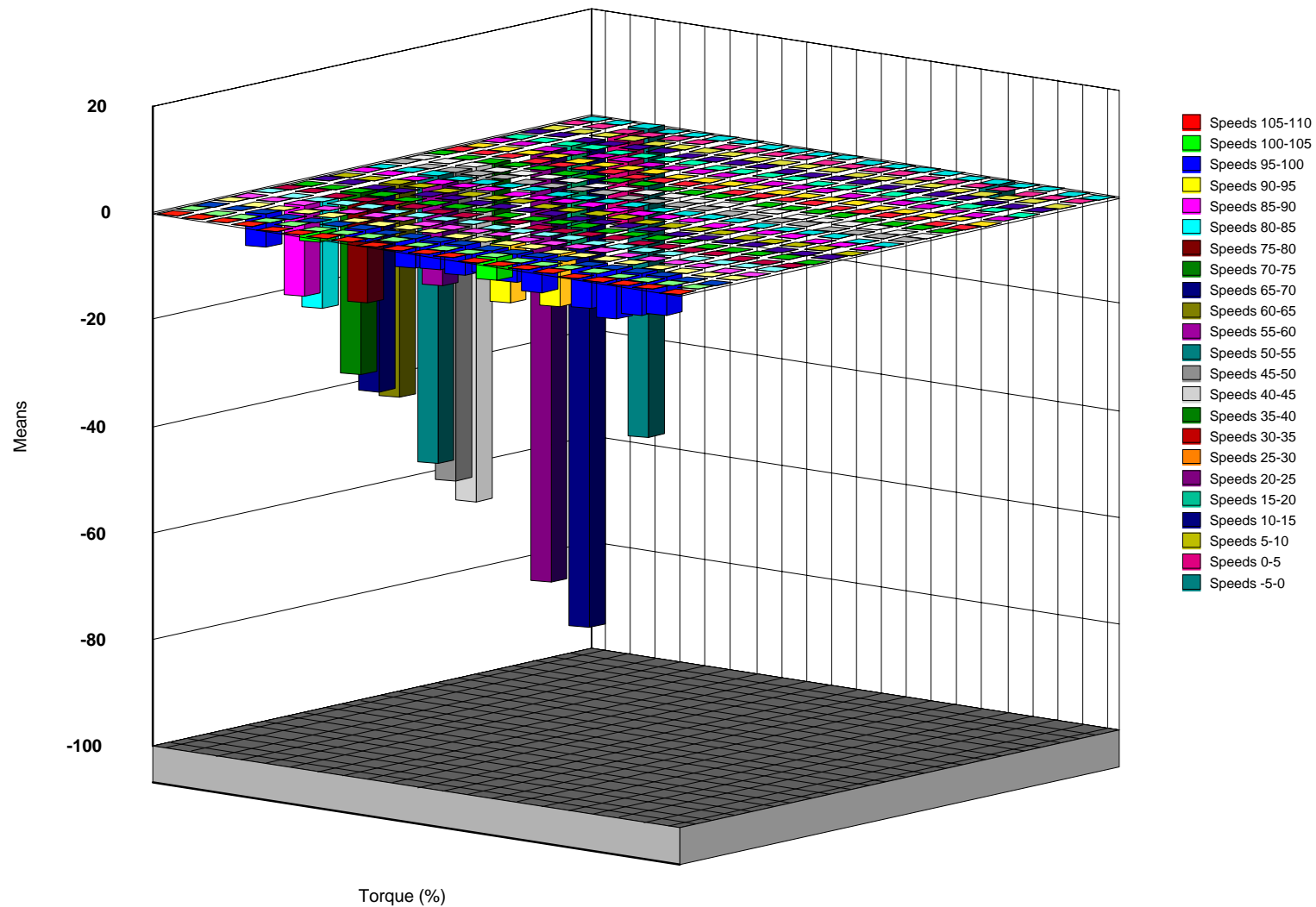


WELDER HIGH SPEED TRANSIENT--Speed Deceleration Sums

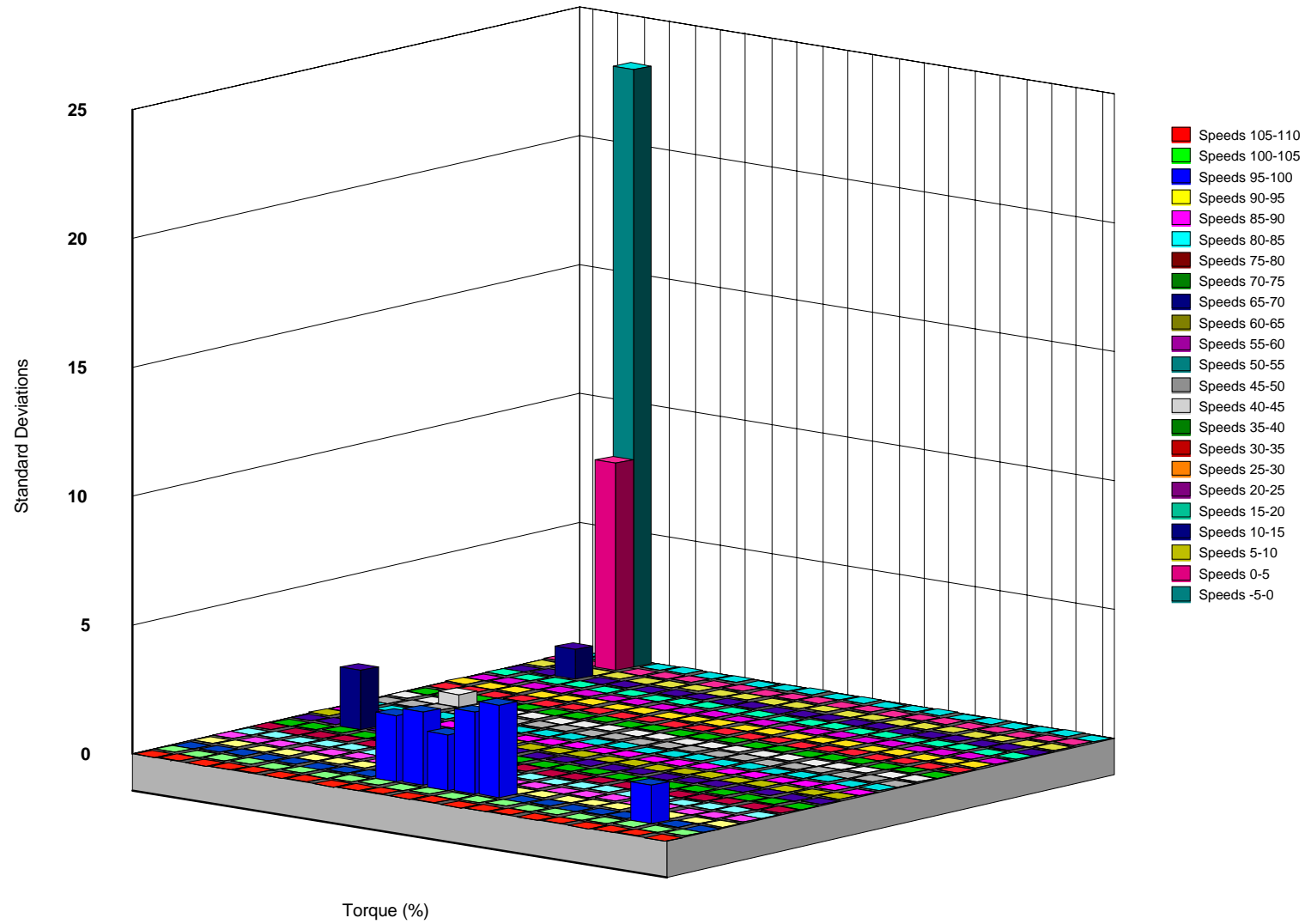




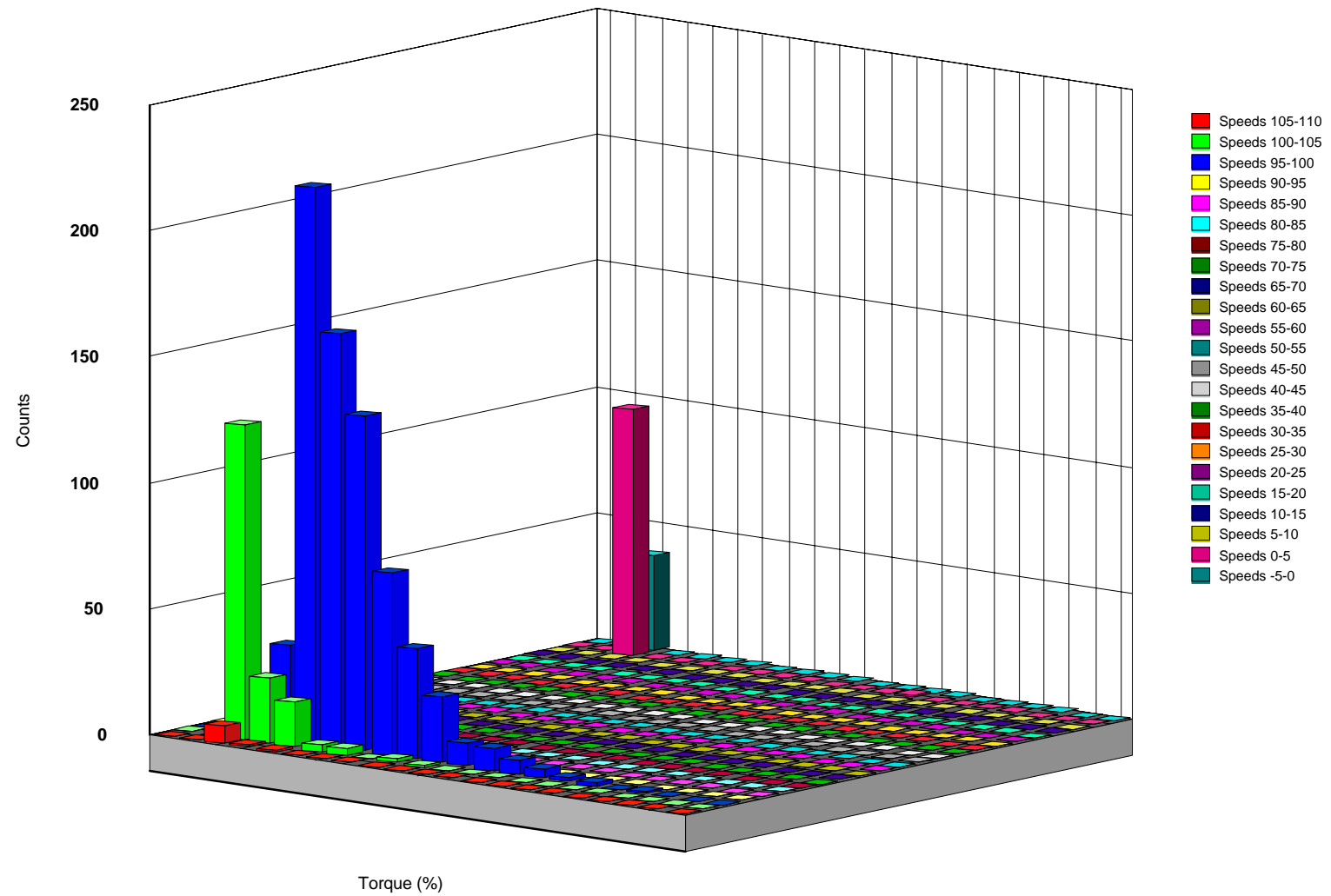
# WELDER HIGH SPEED TRANSIENT--Speed Deceleration Means



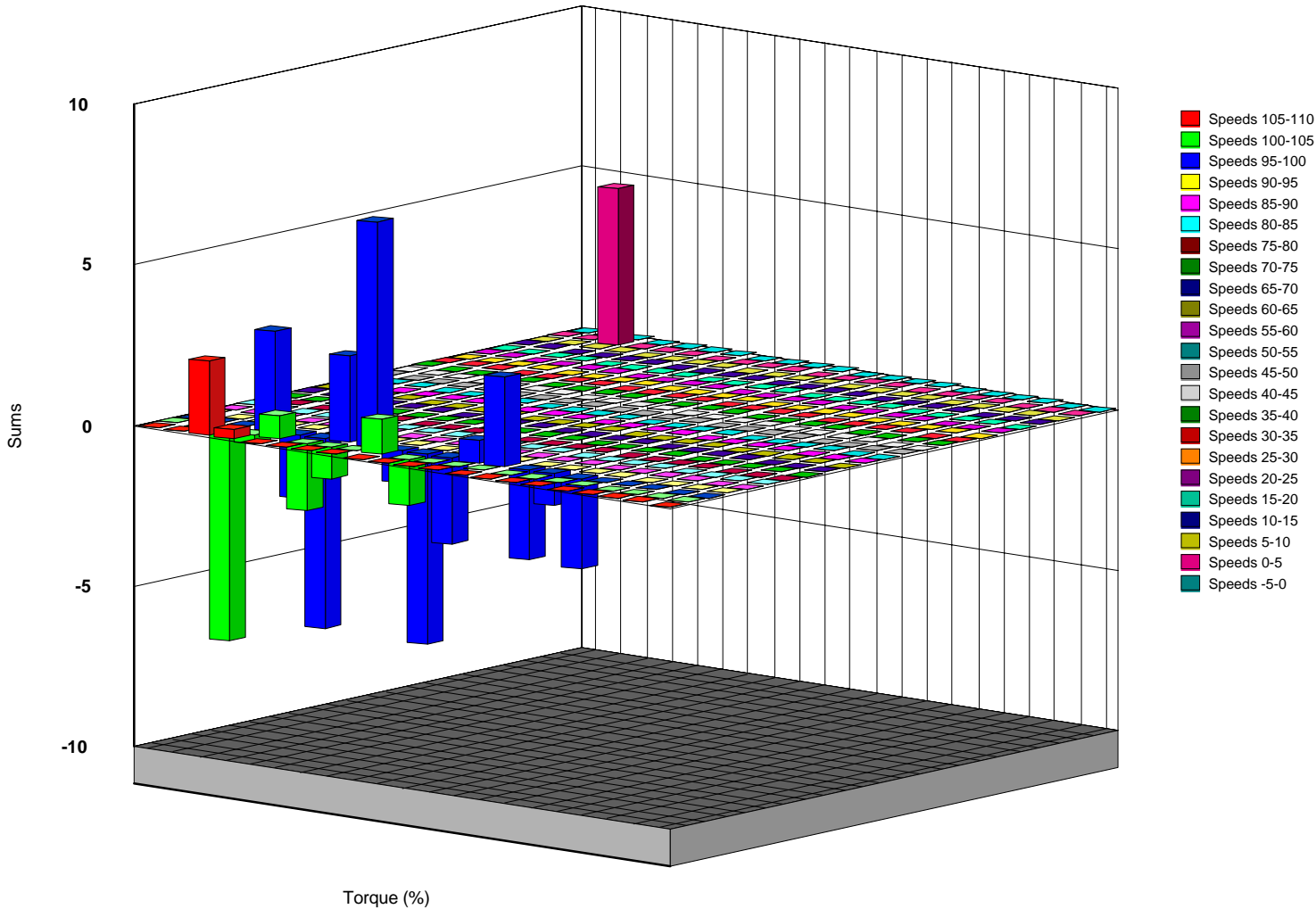
## WELDER HIGH SPEED TRANSIENT--Speed Deceleration Standard Deviations



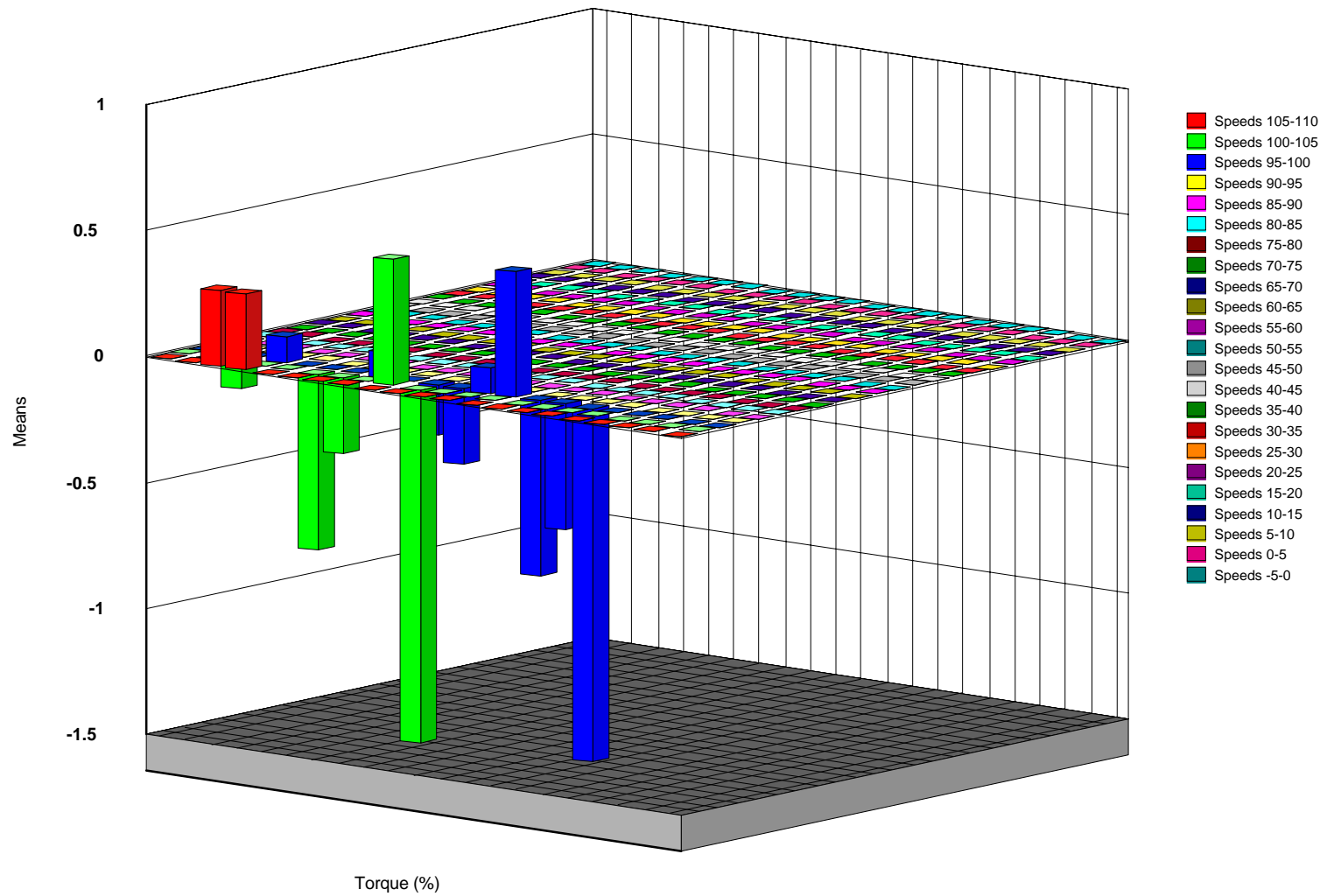
## WELDER HIGH SPEED TRANSIENT--Speed Steady State Counts



# WELDER HIGH SPEED TRANSIENT--Speed Steady State Sums

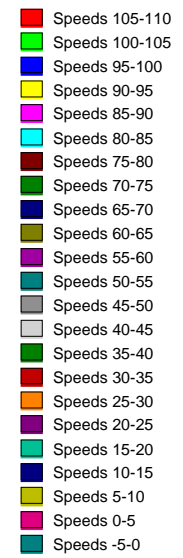


## WELDER HIGH SPEED TRANSIENT--Speed Steady State Means

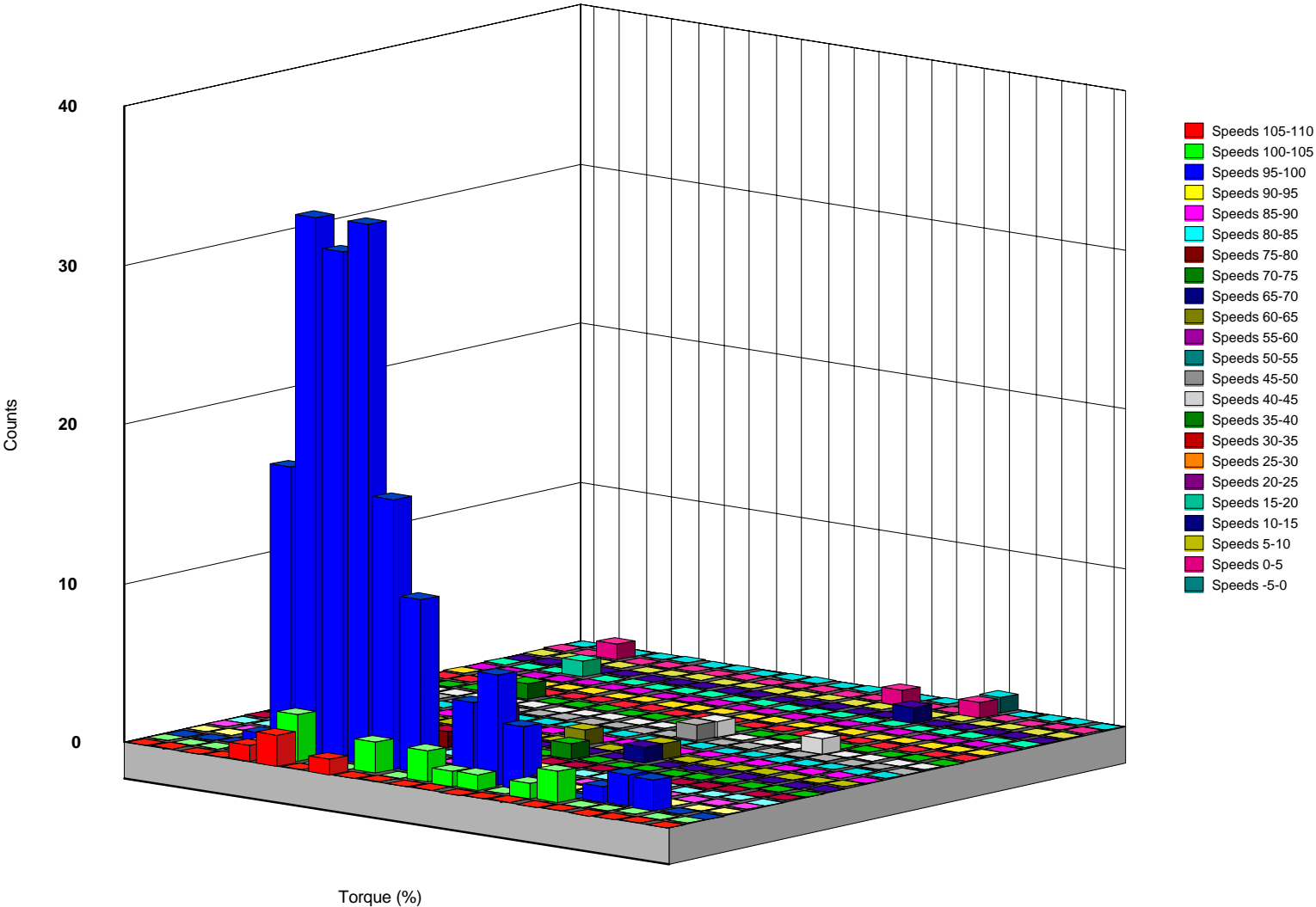


2  
1.5  
1  
0.5  
0

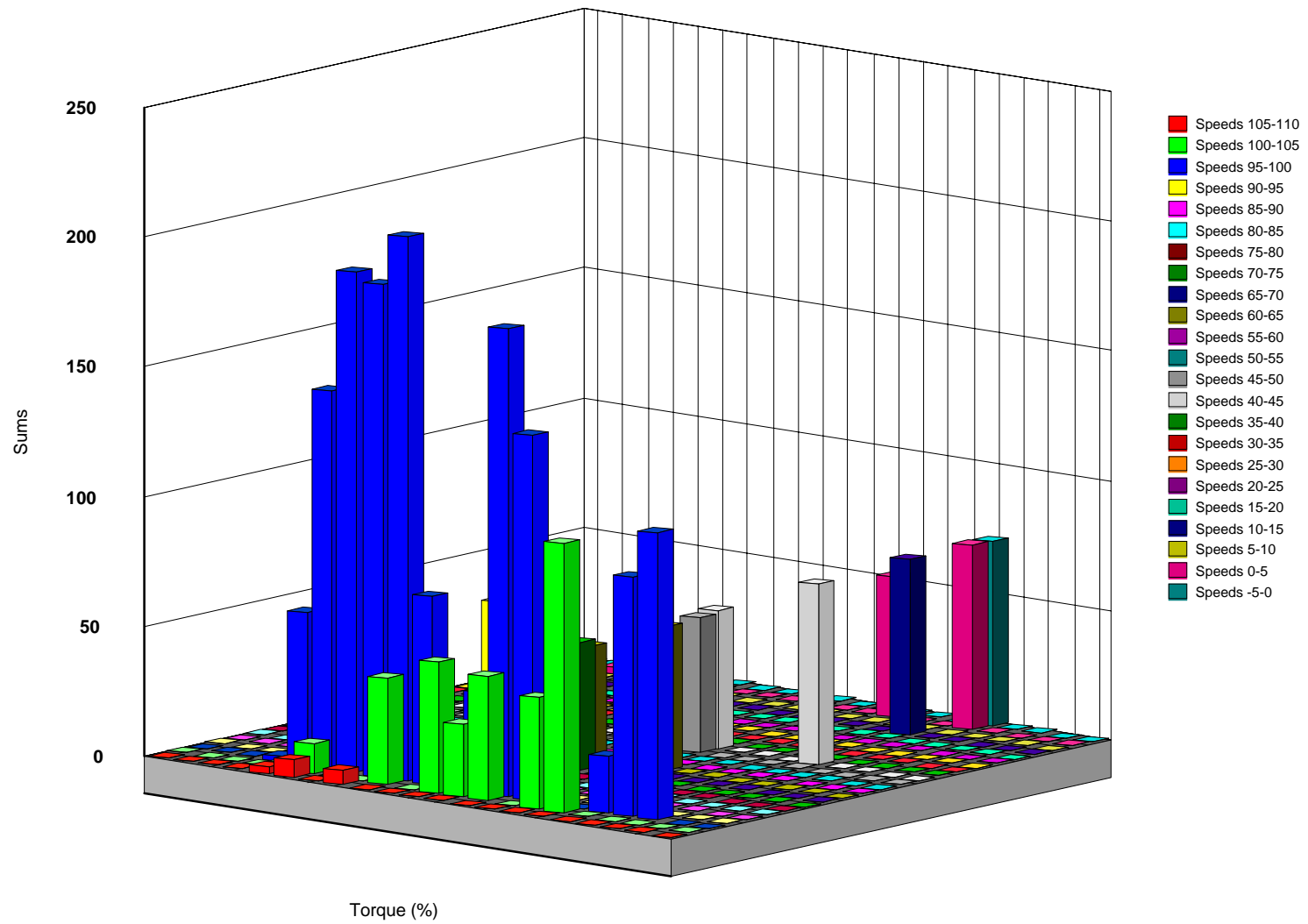
Torque (%)



WELDER HIGH SPEED TRANSIENT--Torque Acceleration Counts

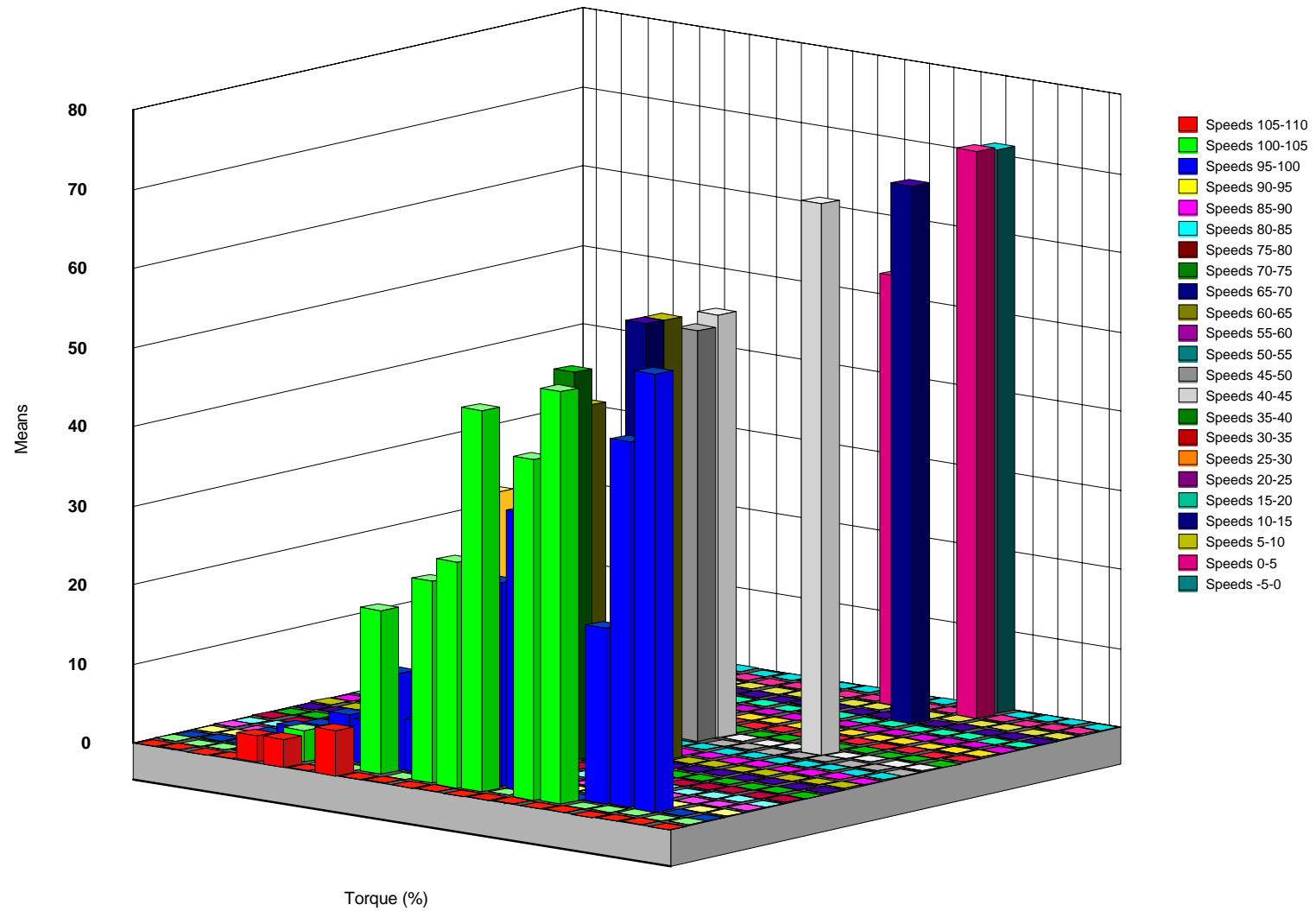


## WELDER HIGH SPEED TRANSIENT--Torque Acceleration Sums

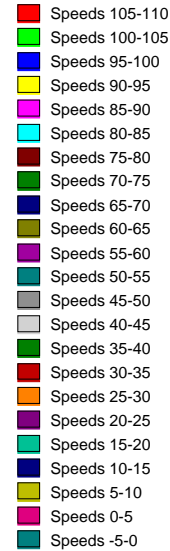




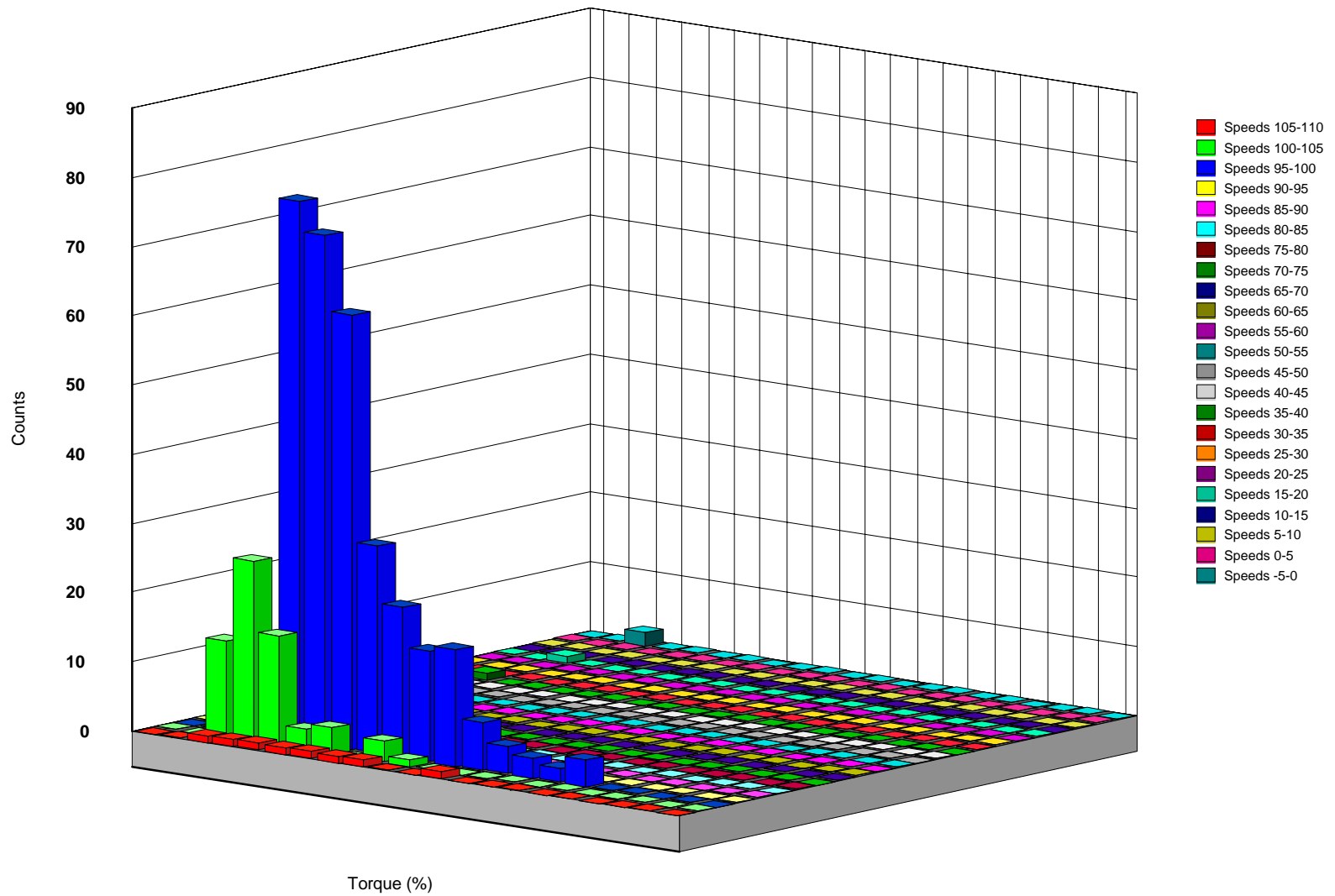
## WELDER HIGH SPEED TRANSIENT--Torque Acceleration Means



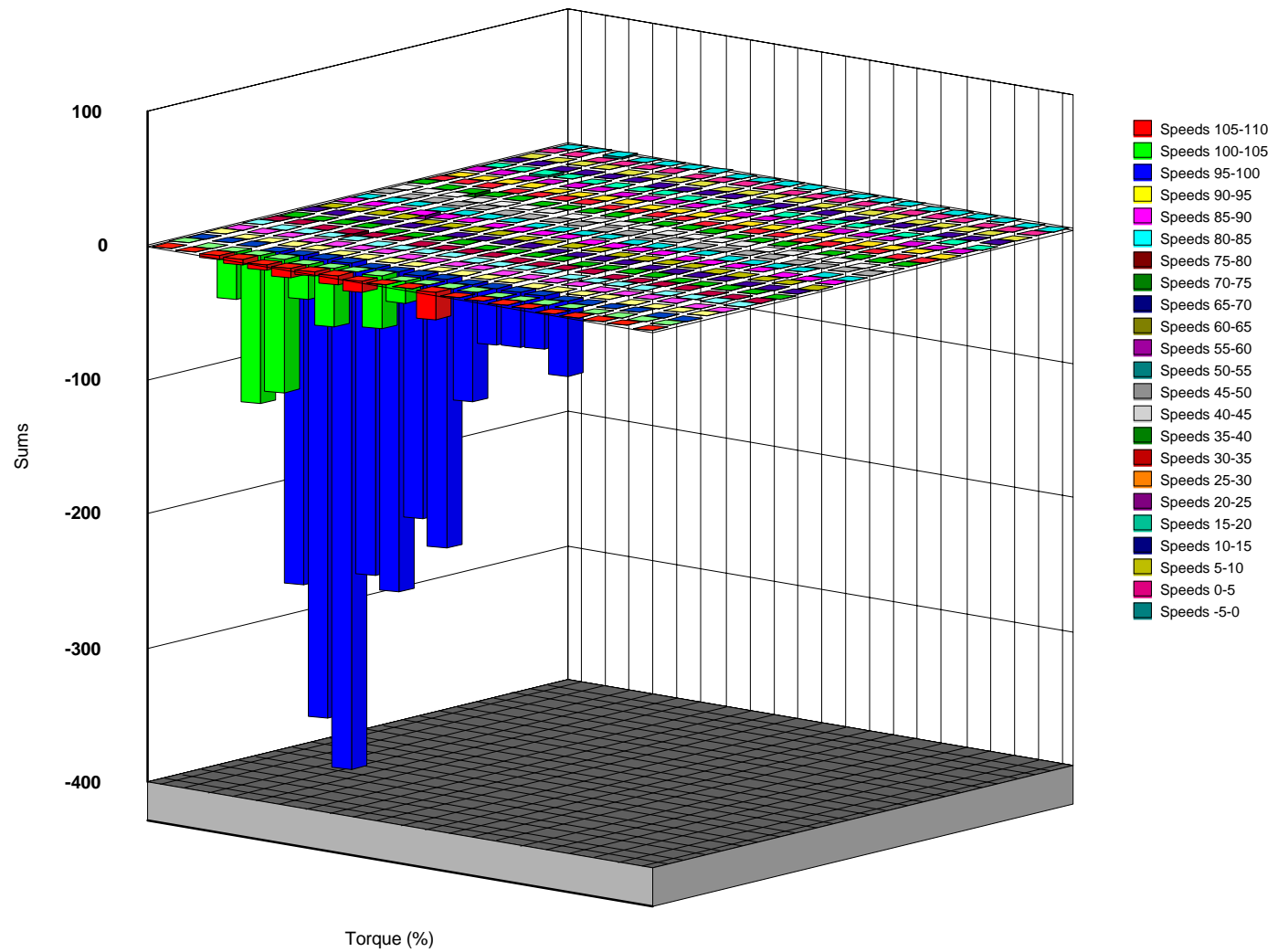
### WELDER HIGH SPEED TRANSIENT--Torque Acceleration Standard Deviations



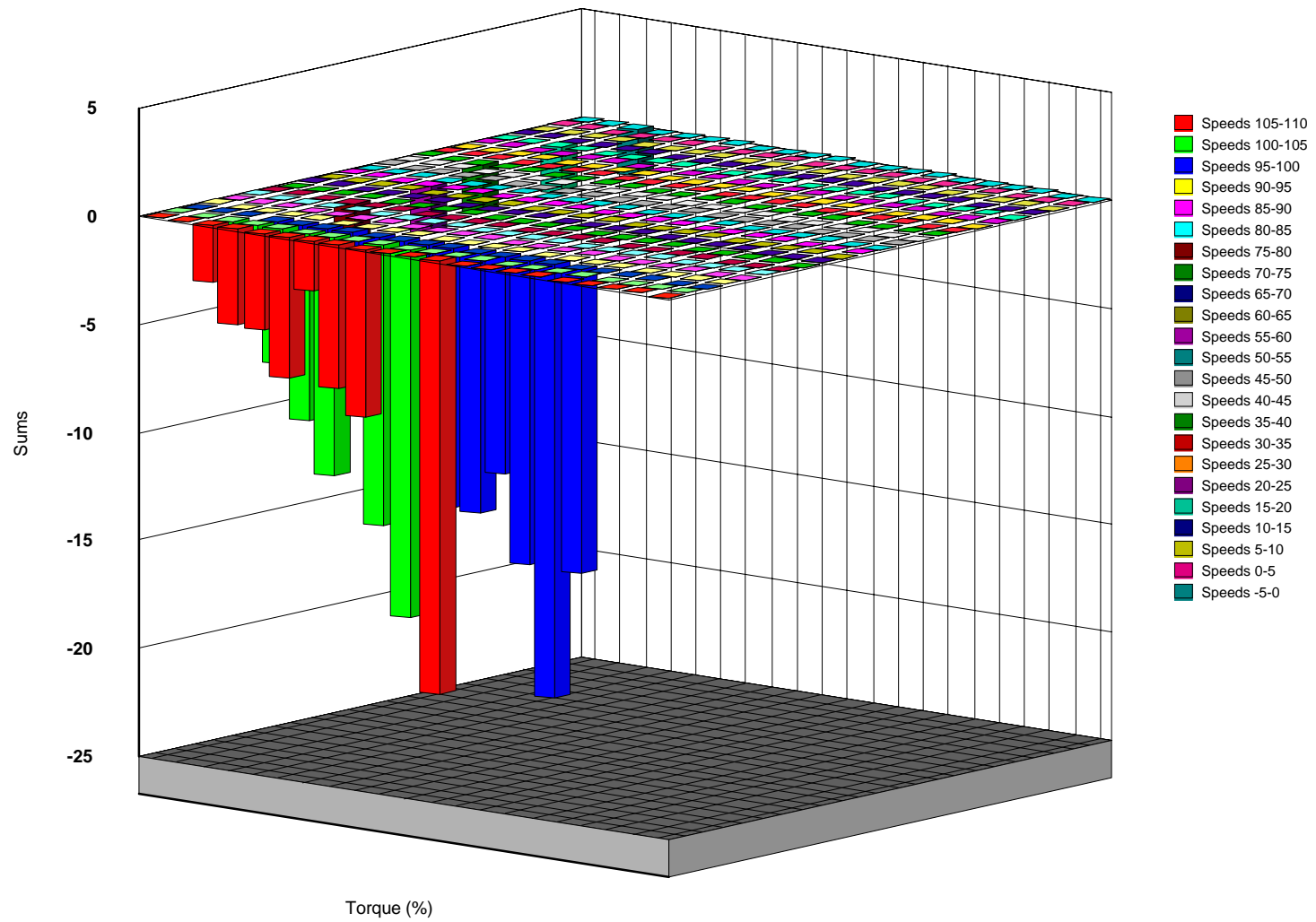
## WELDER HIGH SPEED TRANSIENT--Torque Deceleration Counts



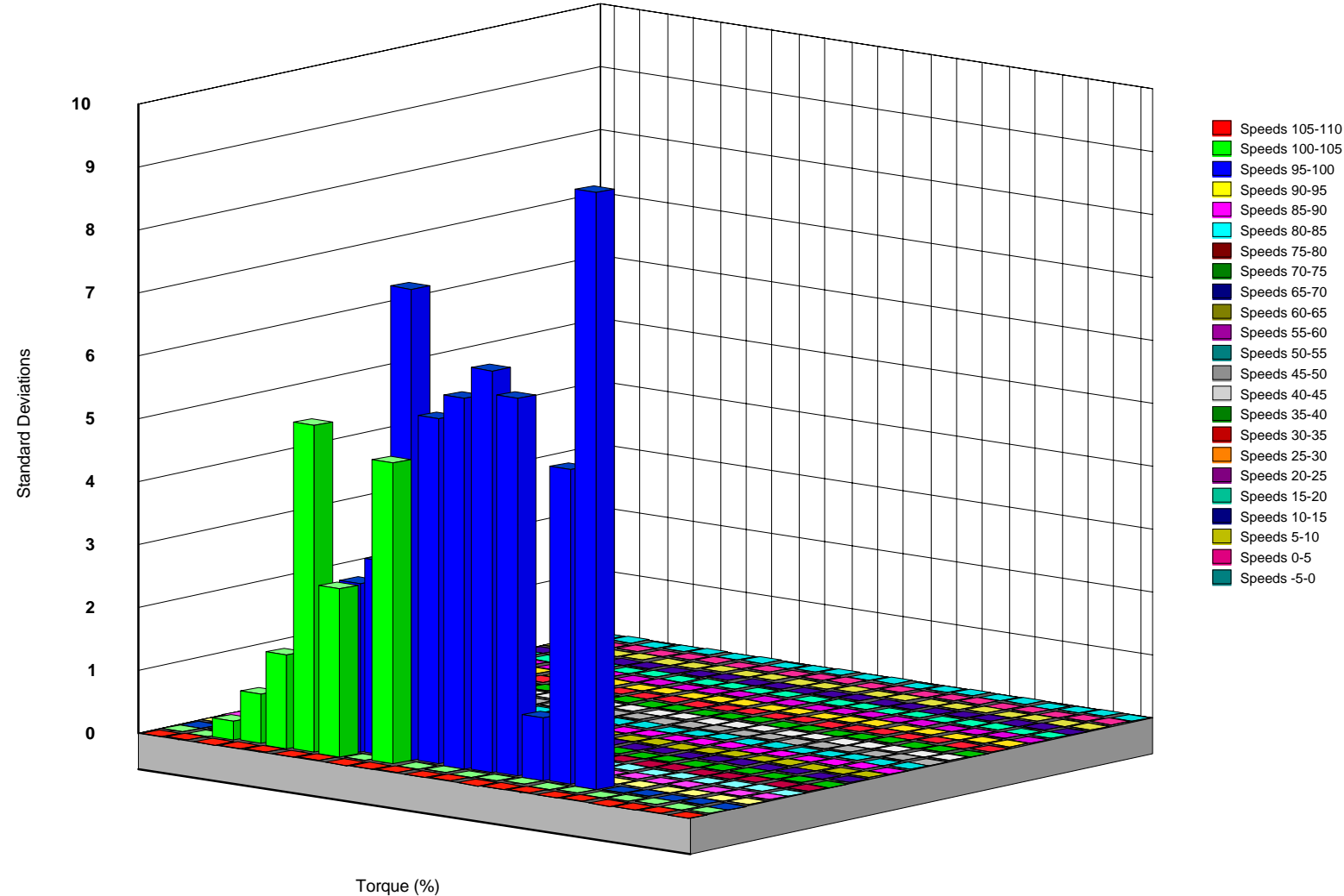
## WELDER HIGH SPEED TRANSIENT--Torque Deceleration Sums



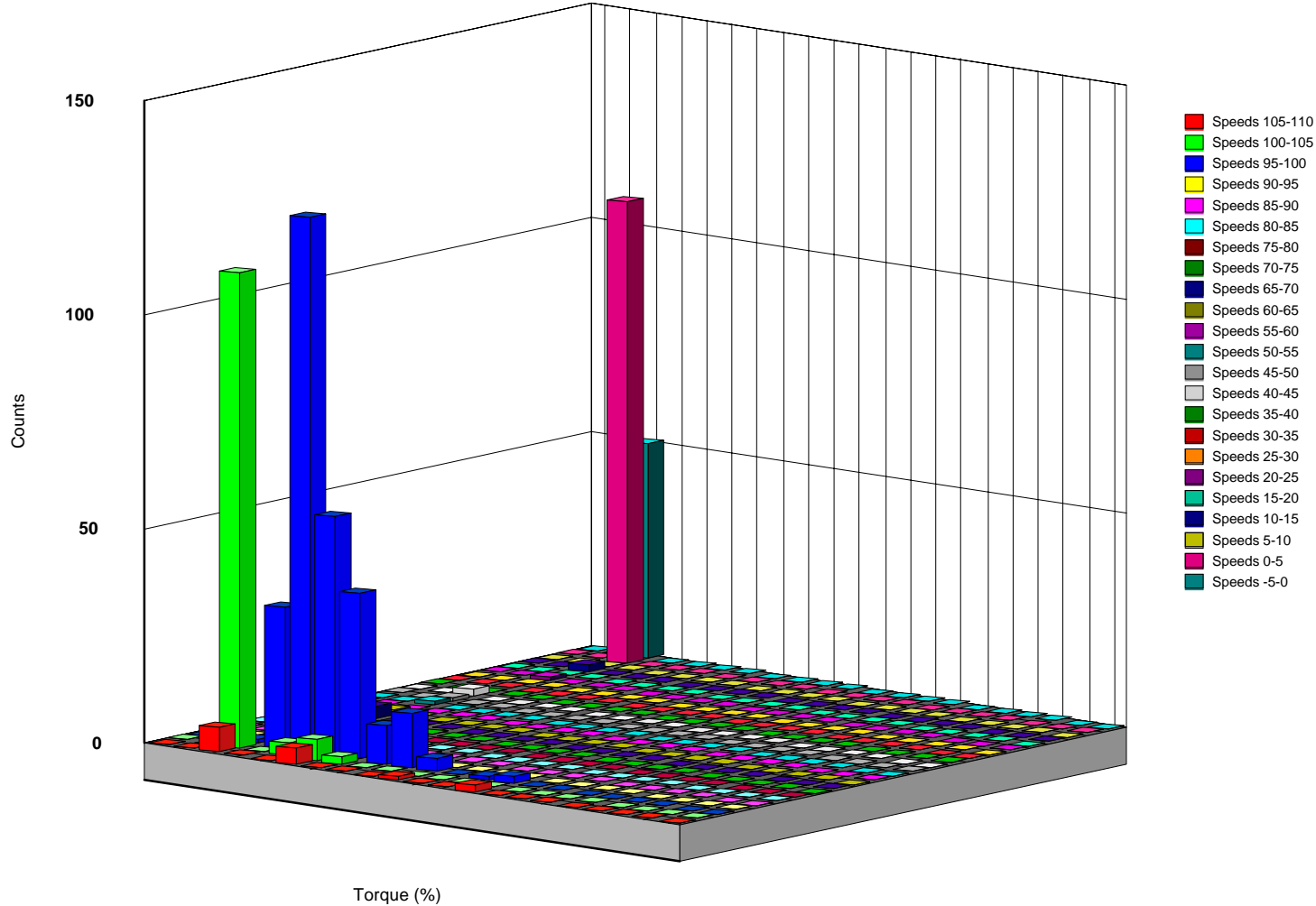
## WELDER HIGH SPEED TRANSIENT--Torque Deceleration Means



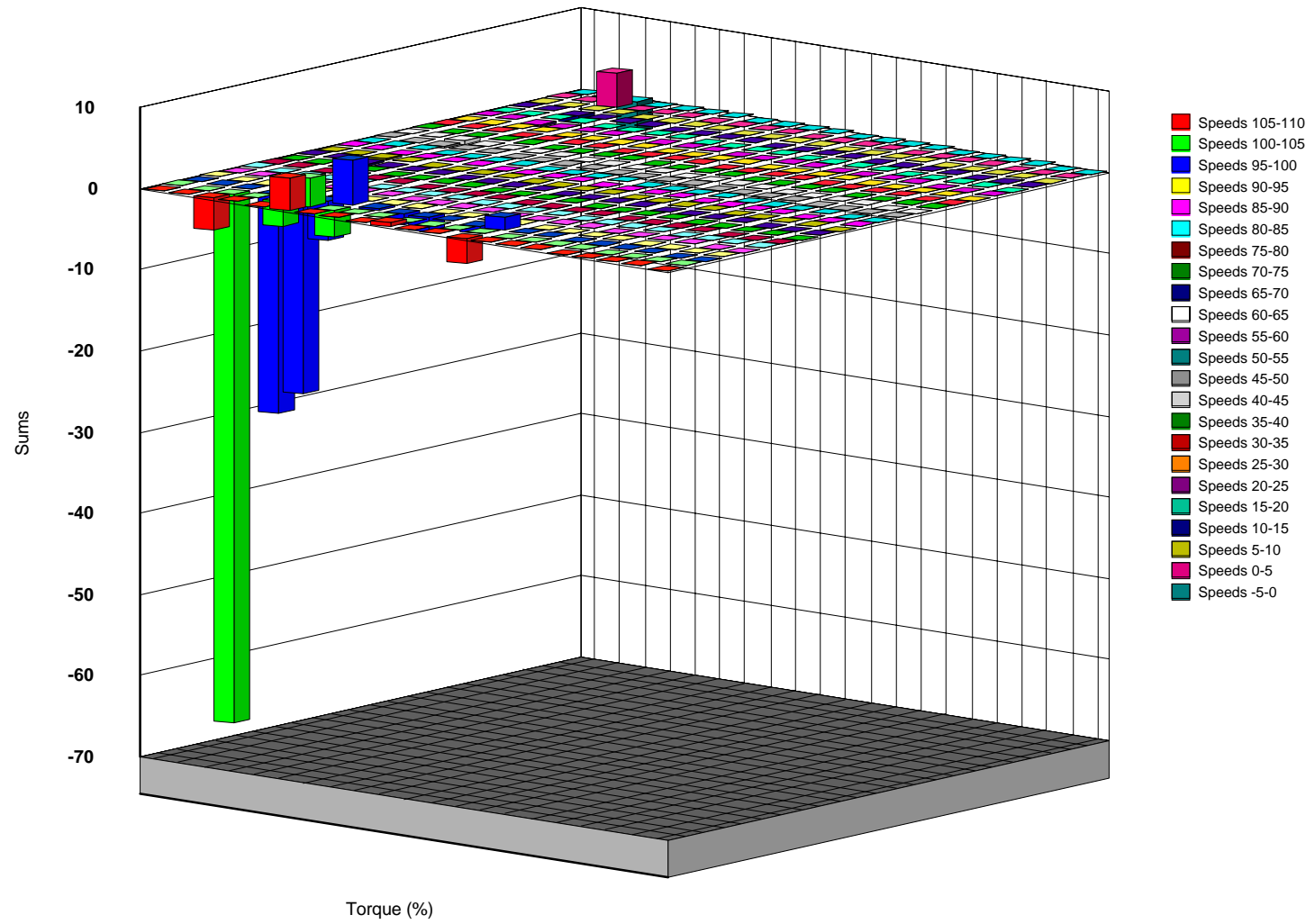
WELDER HIGH SPEED TRANSIENT--Torque Deceleration Standard Deviations



WELDER HIGH SPEED TRANSIENT--Torque Steady State Counts

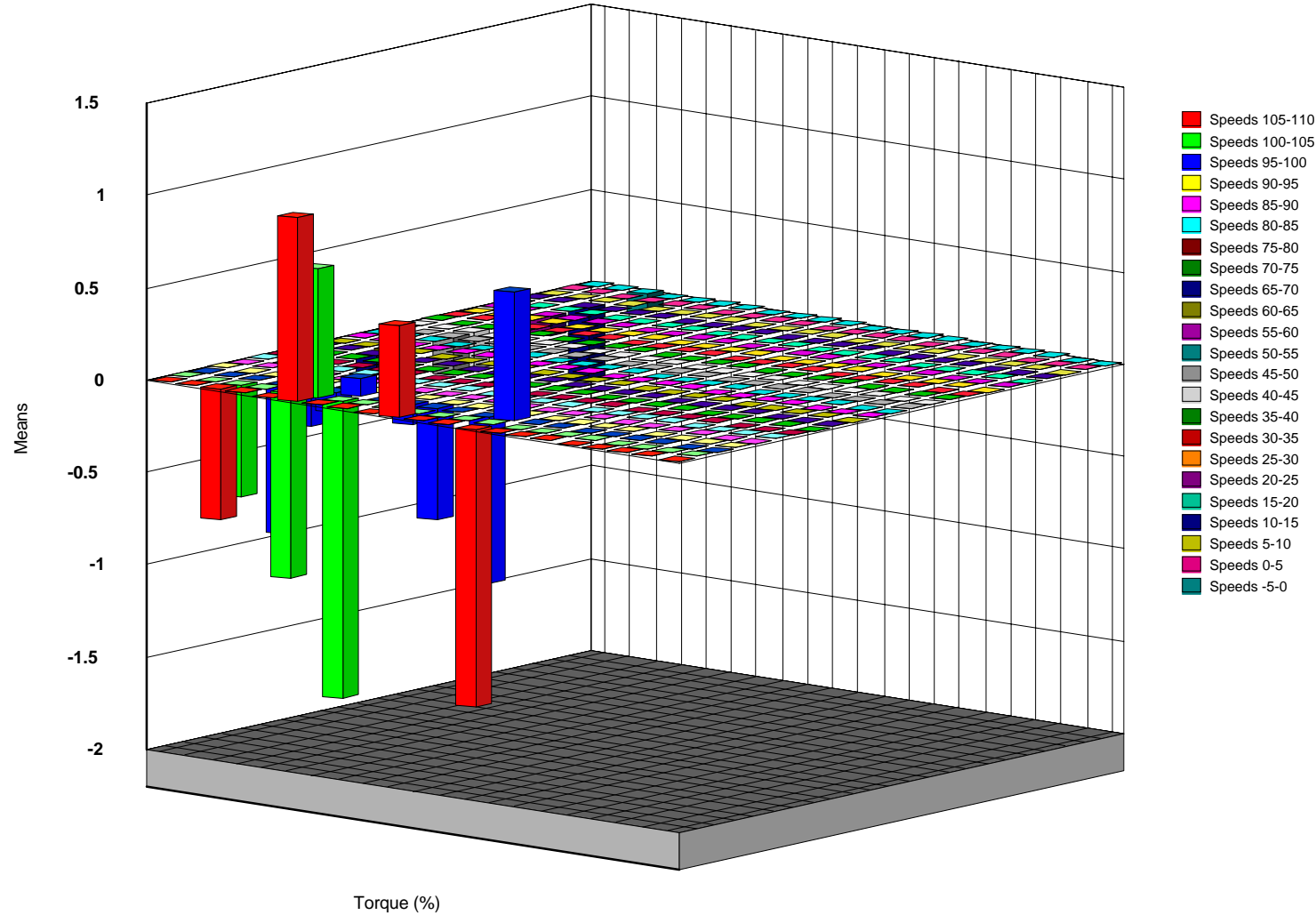


WELDER HIGH SPEED TRANSIENT--Torque Steady State Sums

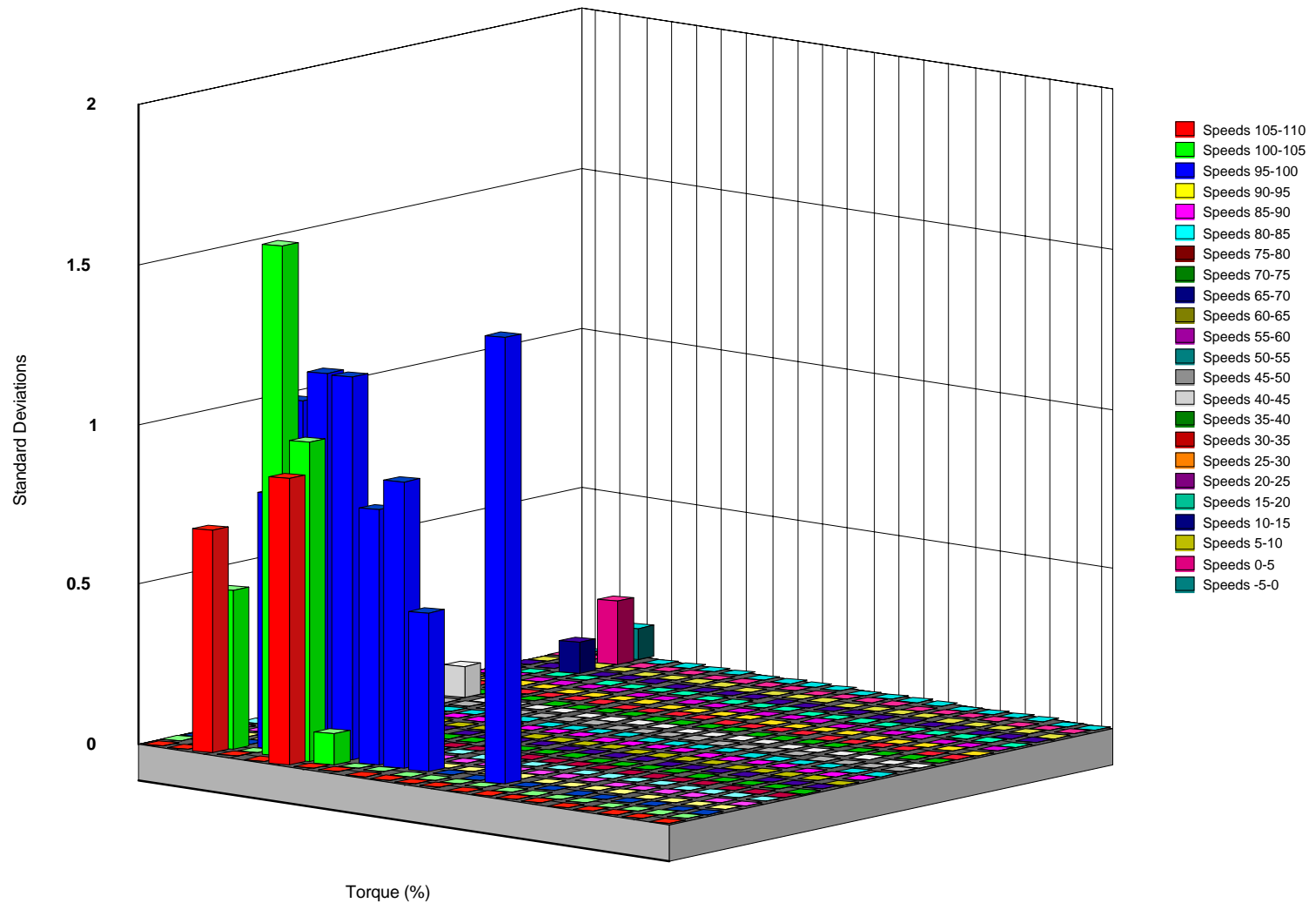




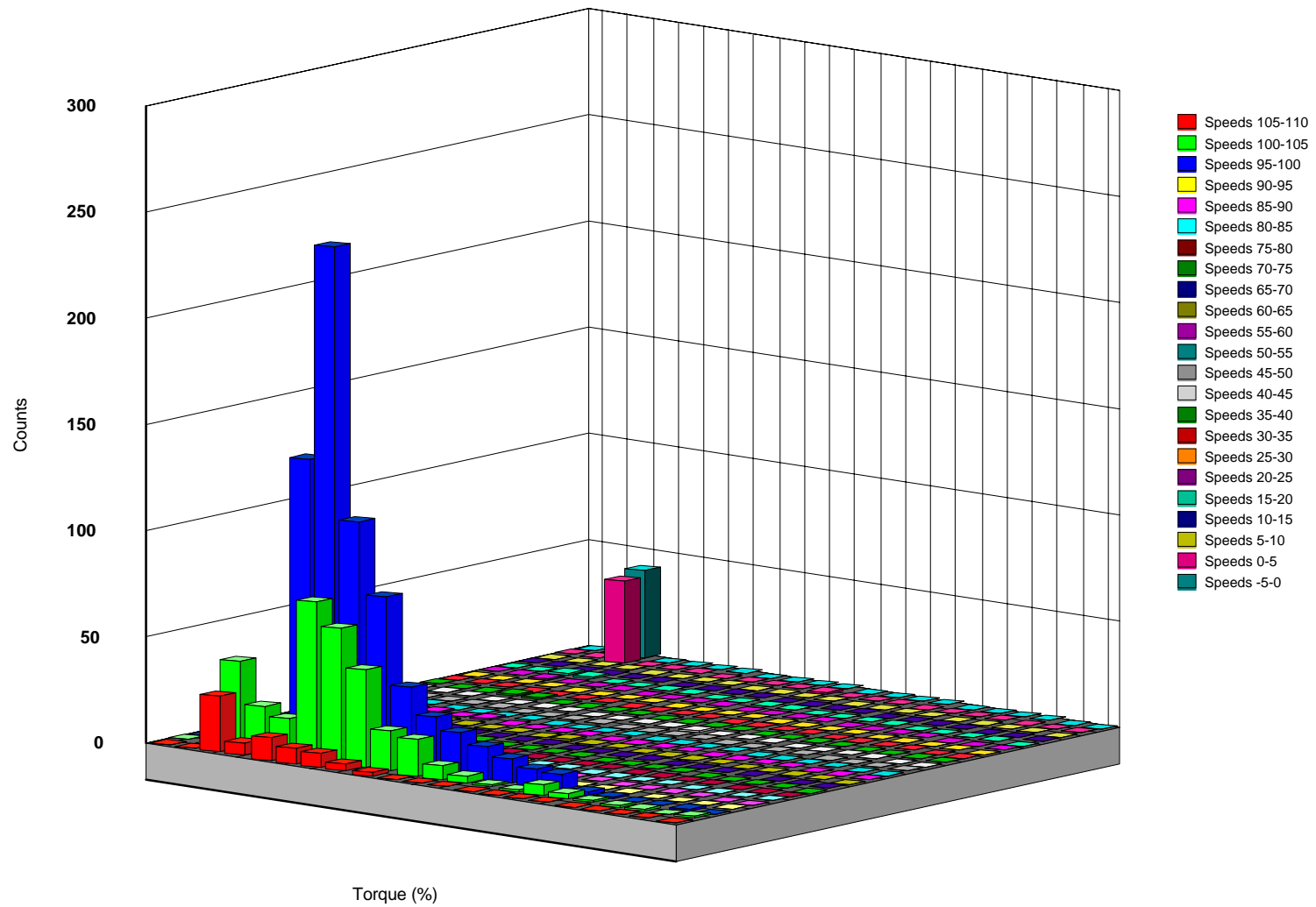
WELDER HIGH SPEED TRANSIENT--Torque Steady State Means



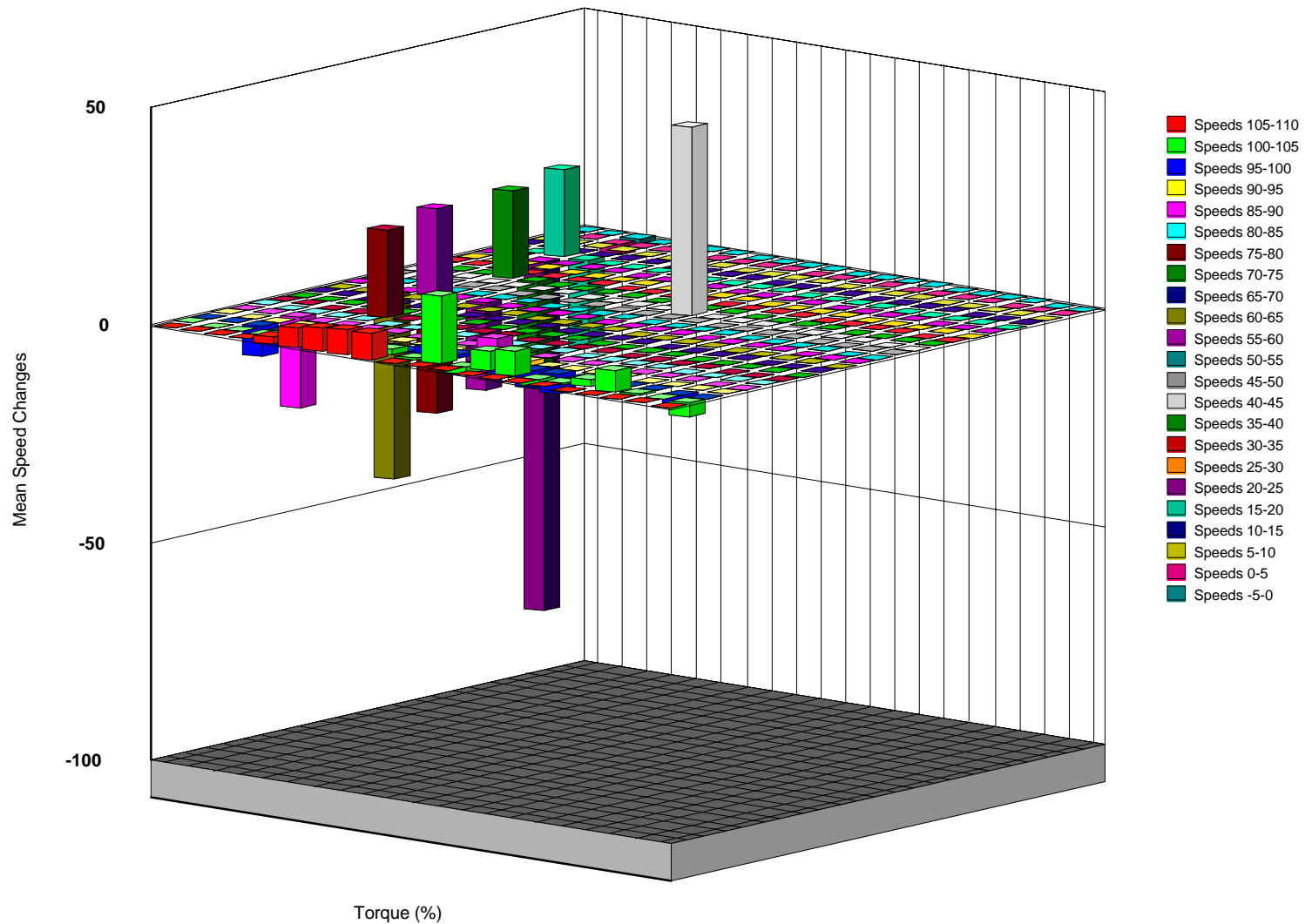
### WELDER HIGH SPEED TRANSIENT--Torque Steady State Standard Deviations



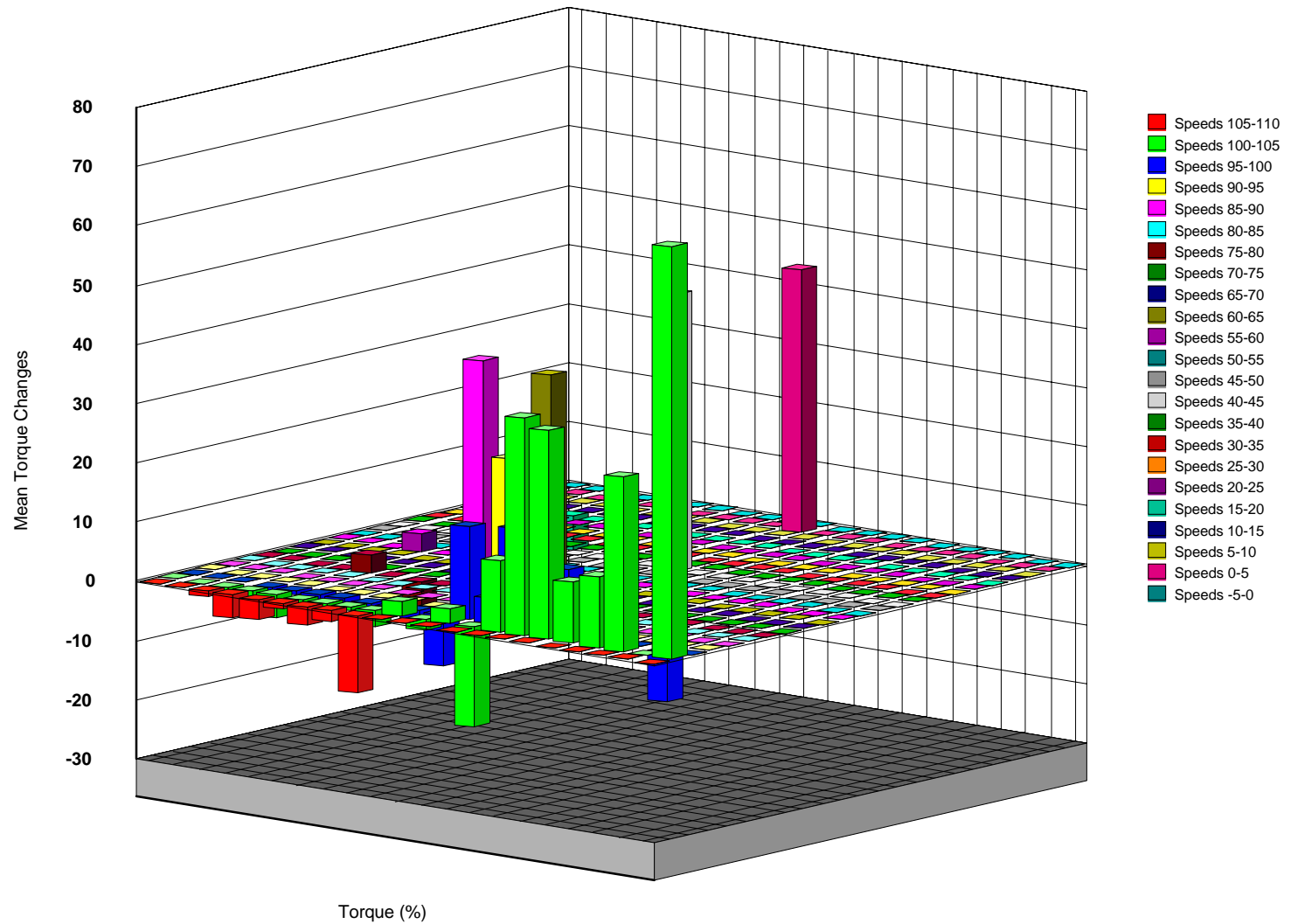
## WELDER HIGH TORQUE TRANSIENT--Counts



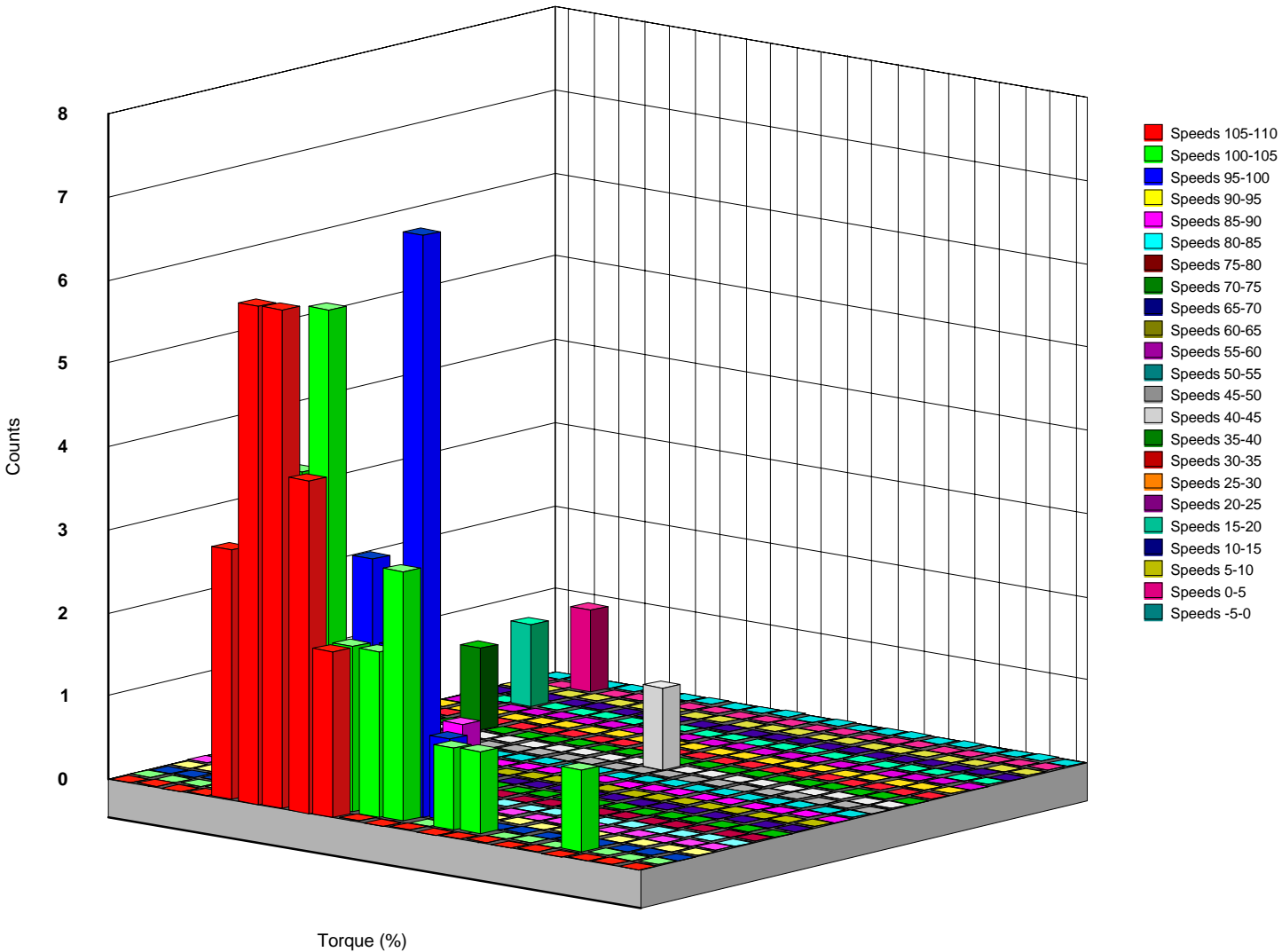
## WELDER HIGH TORQUE TRANSIENT--Mean Speed Changes



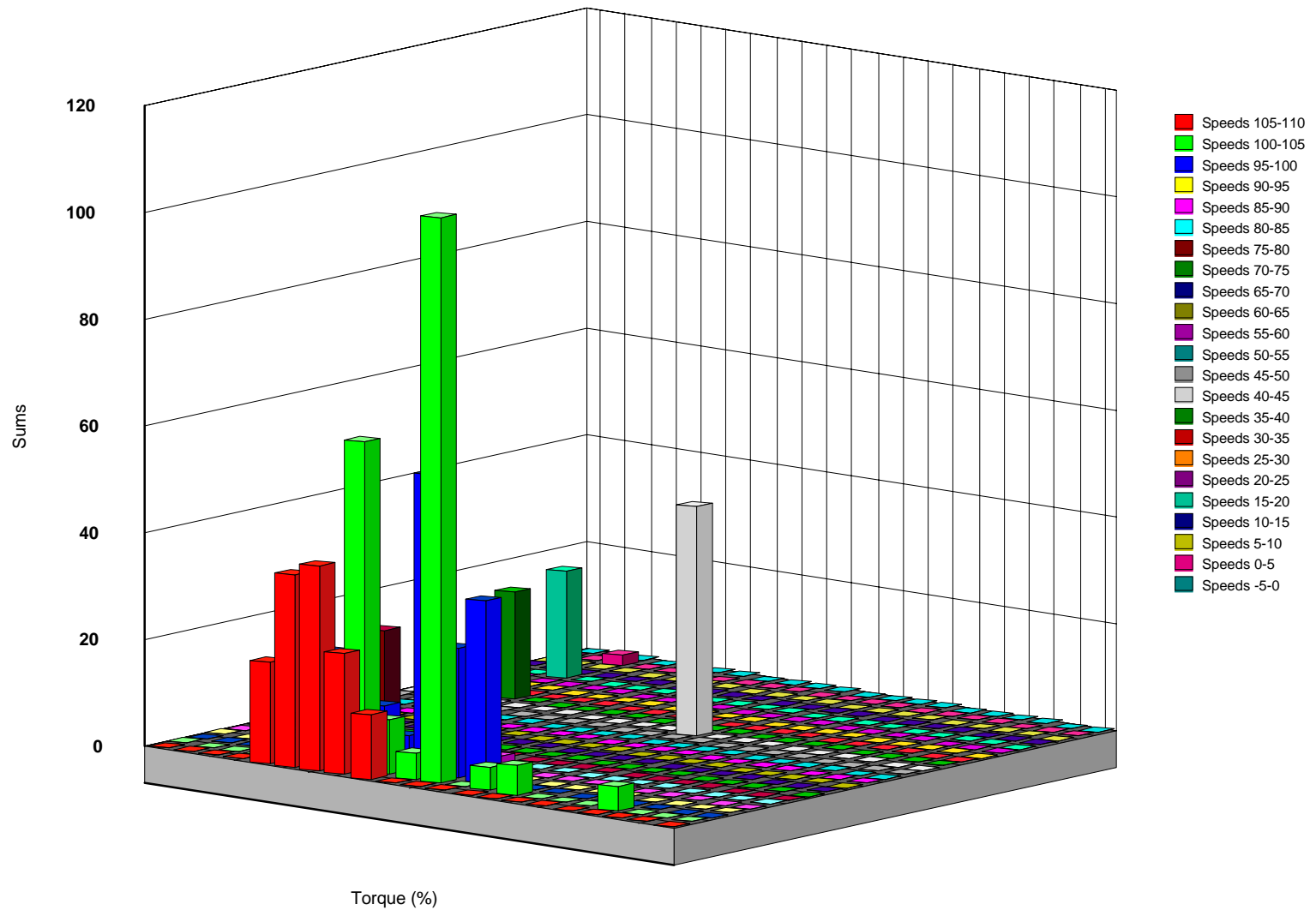
## WELDER HIGH TORQUE TRANSIENT--Mean Torque Changes



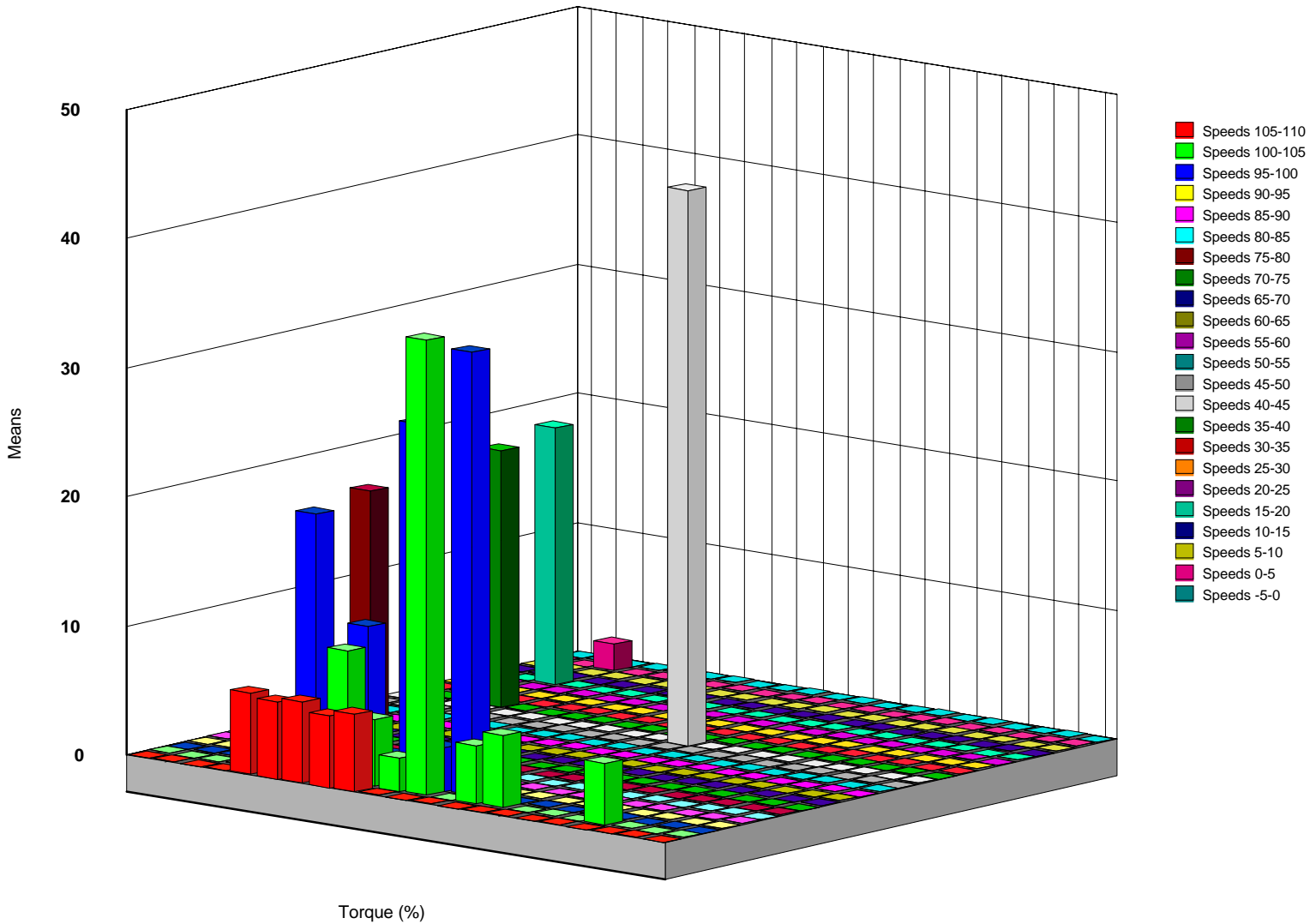
## WELDER HIGH TORQUE TRANSIENT--Speed Acceleration Counts



## WELDER HIGH TORQUE TRANSIENT--Speed Acceleration Sums

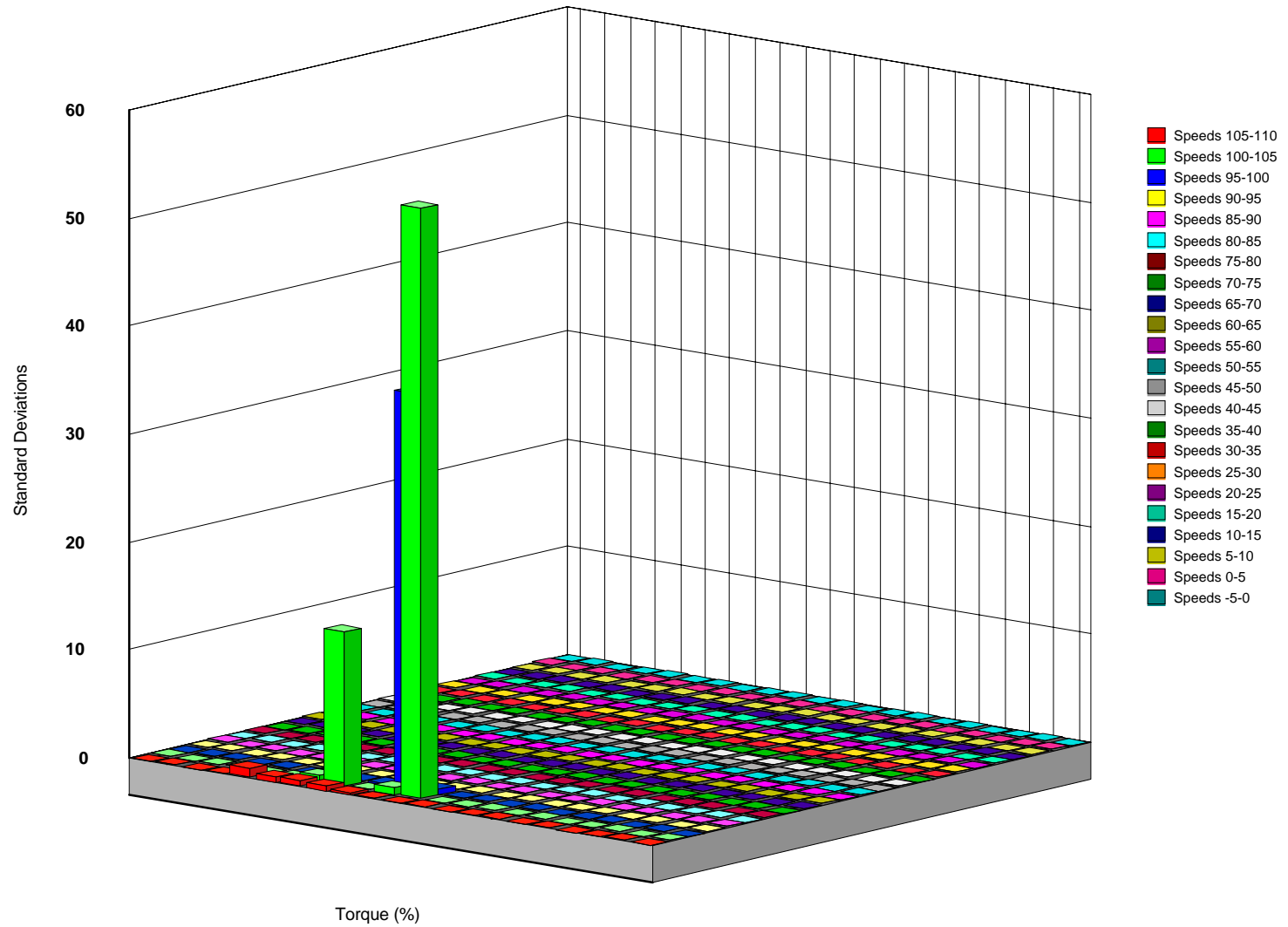


## WELDER HIGH TORQUE TRANSIENT--Speed Acceleration Means

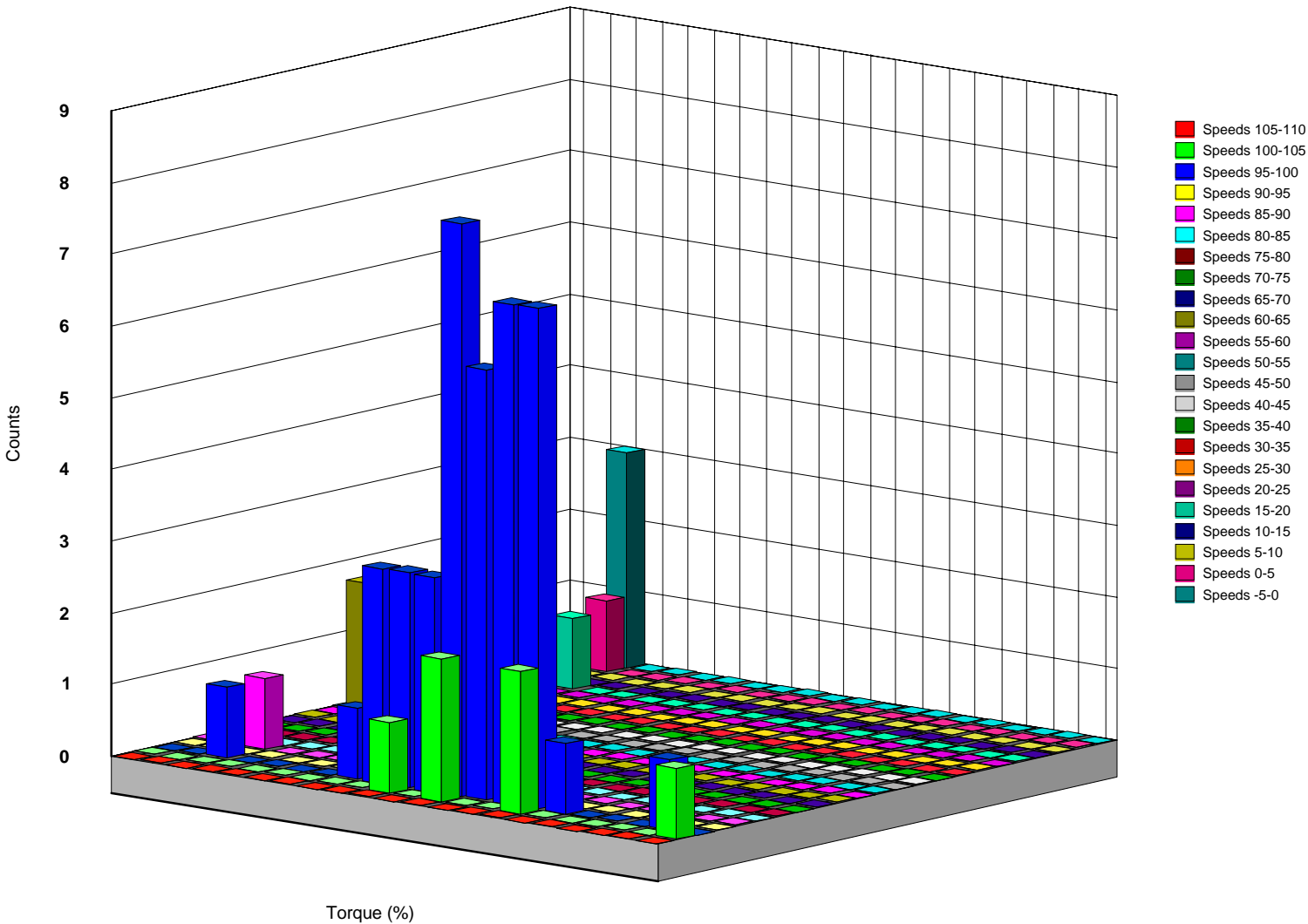




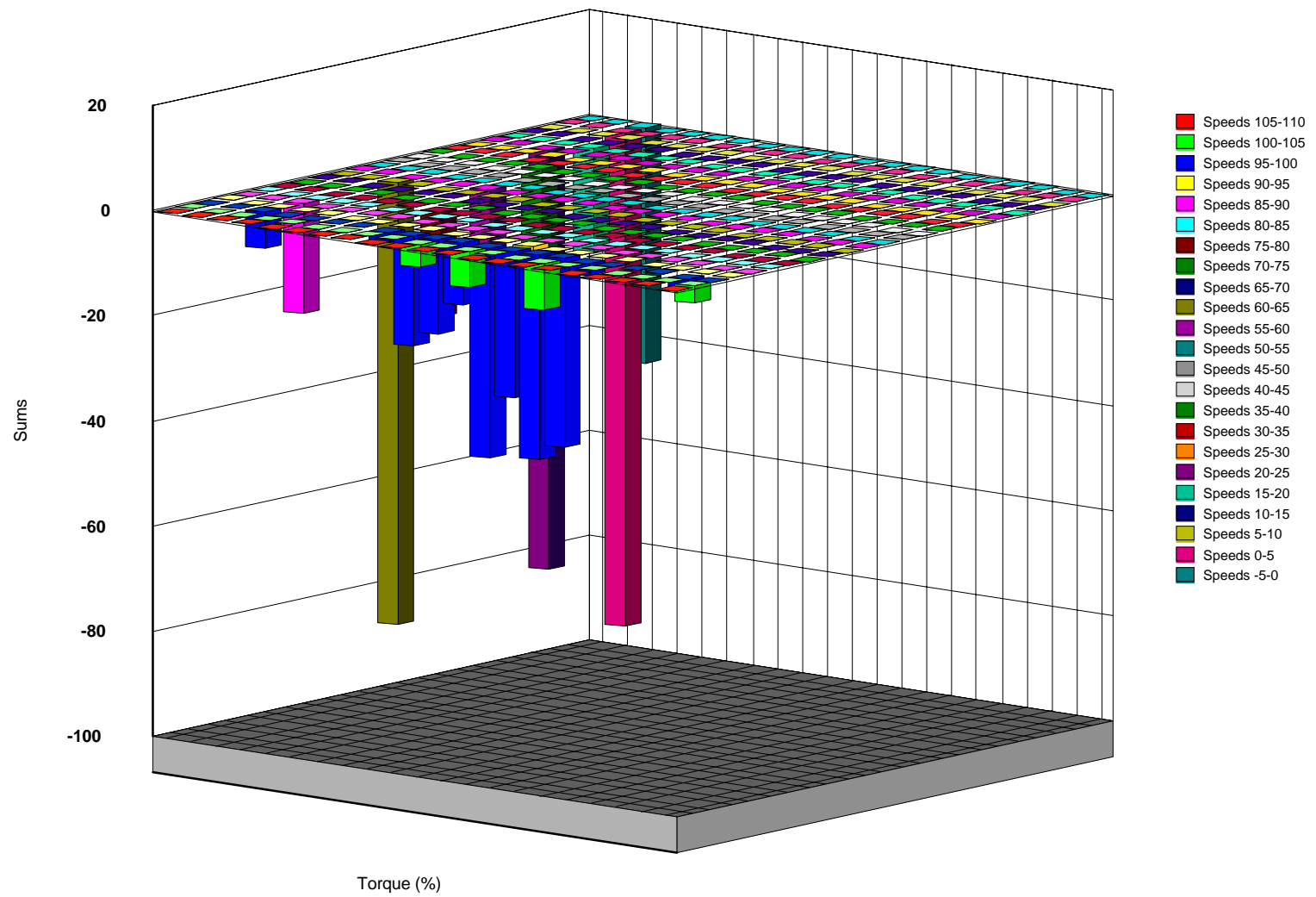
## WELDER HIGH TORQUE TRANSIENT--Speed Acceleration Standard Deviations



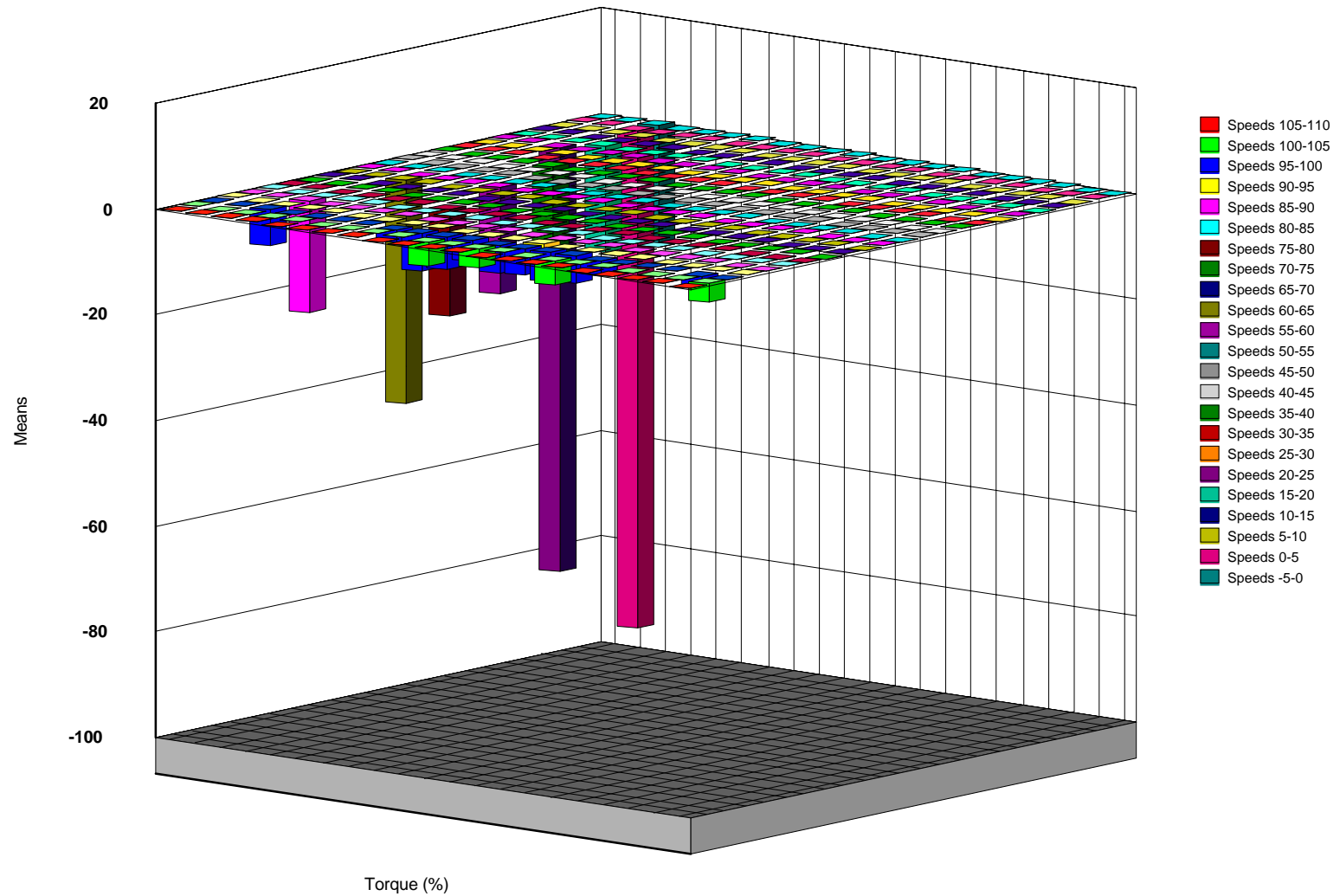
## WELDER HIGH TORQUE TRANSIENT--Speed Deceleration Counts



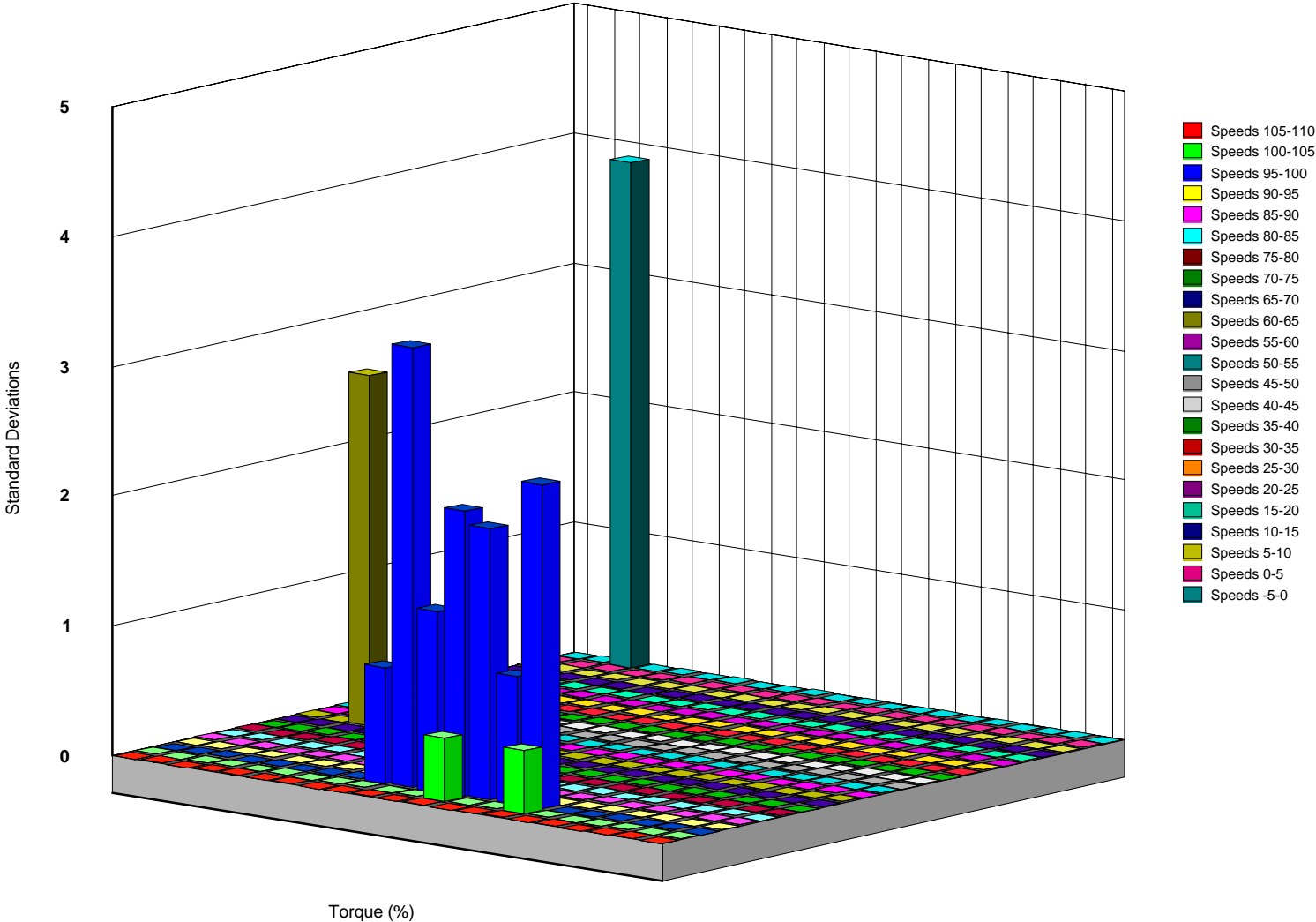
## WELDER HIGH TORQUE TRANSIENT--Speed Deceleration Sums



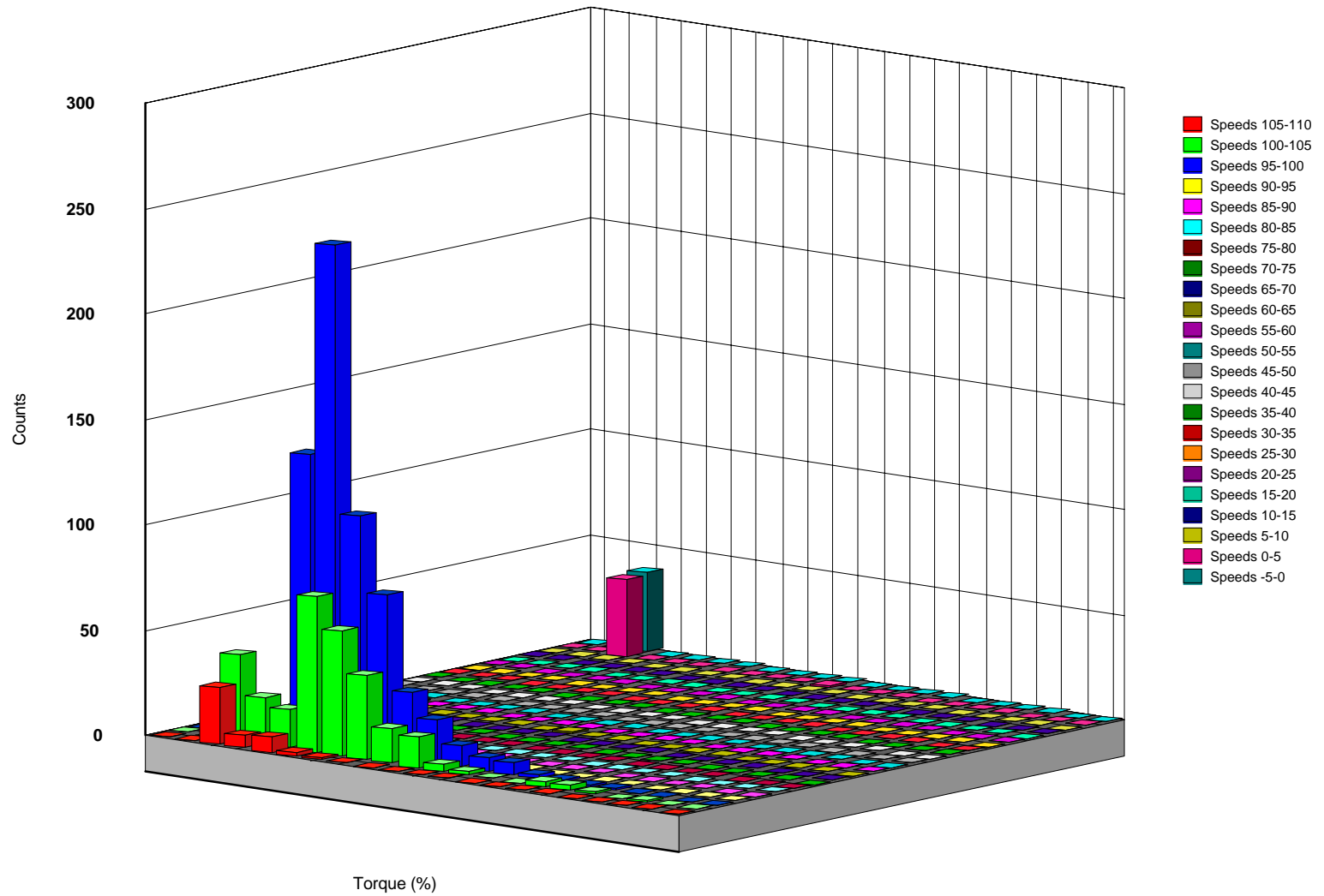
## WELDER HIGH TORQUE TRANSIENT--Speed Deceleration Means



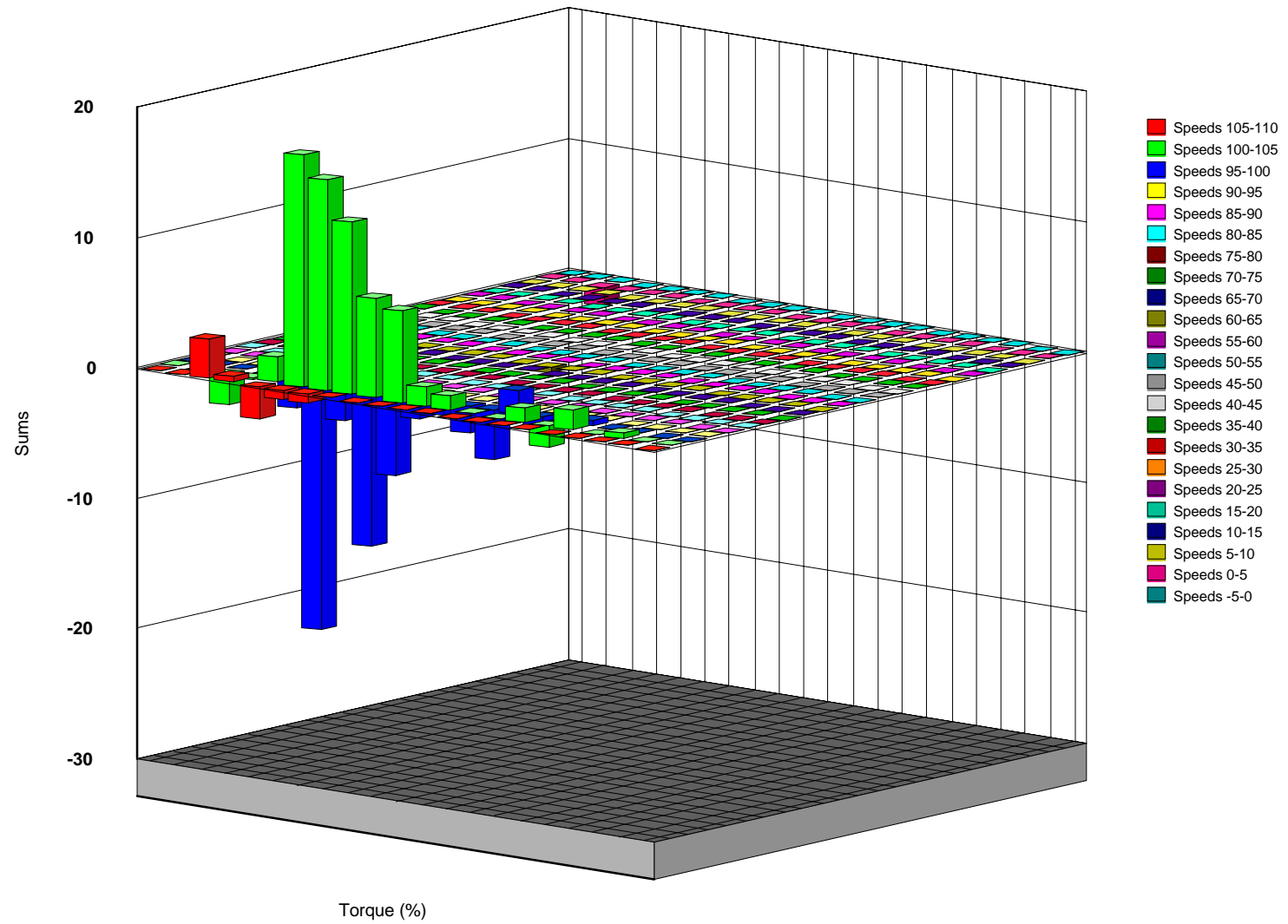
WELDER HIGH TORQUE TRANSIENT--Speed Deceleration Standard Deviations



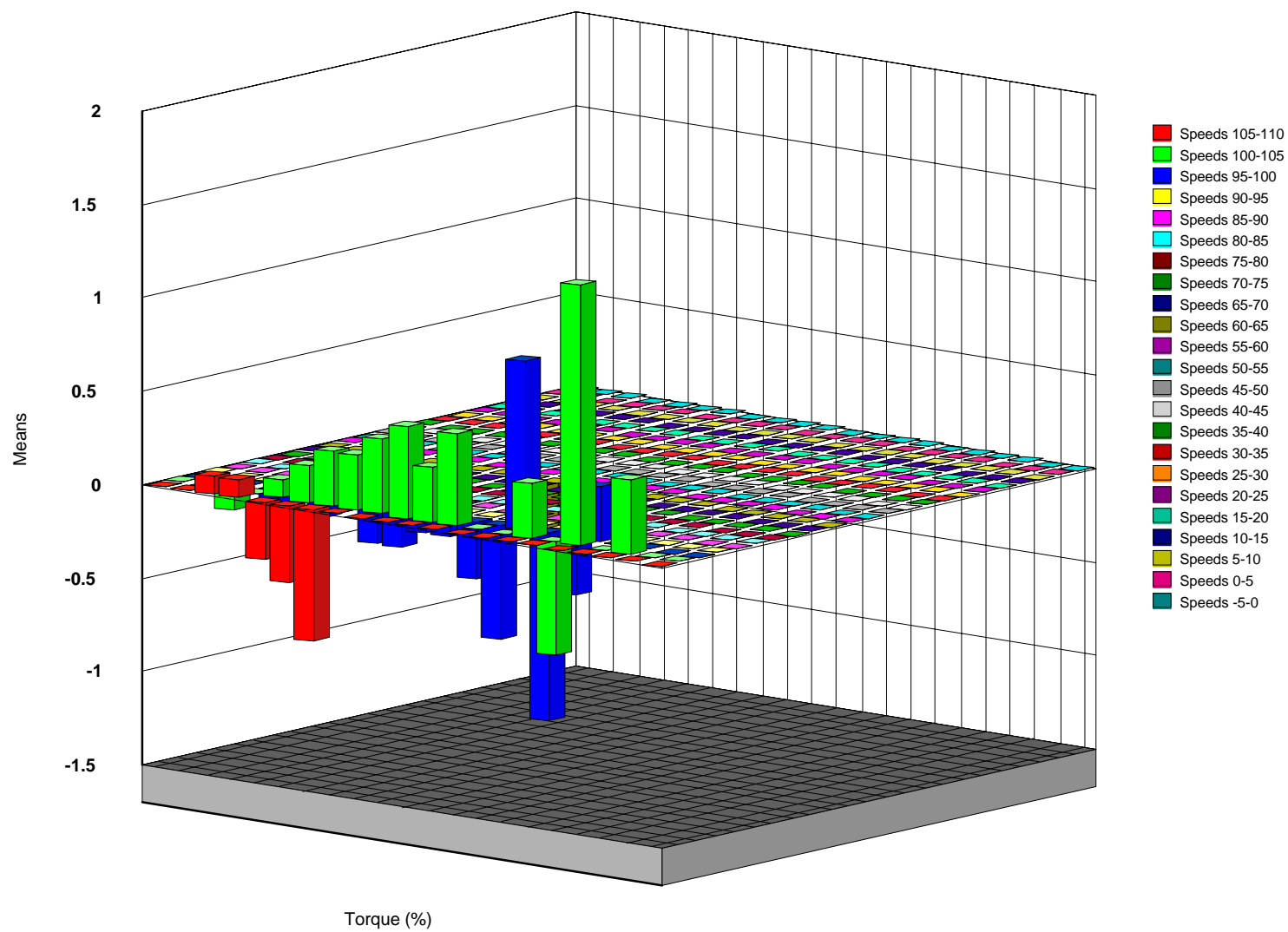
## WELDER HIGH TORQUE TRANSIENT--Speed Steady State Counts



## WELDER HIGH TORQUE TRANSIENT--Speed Steady State Sums

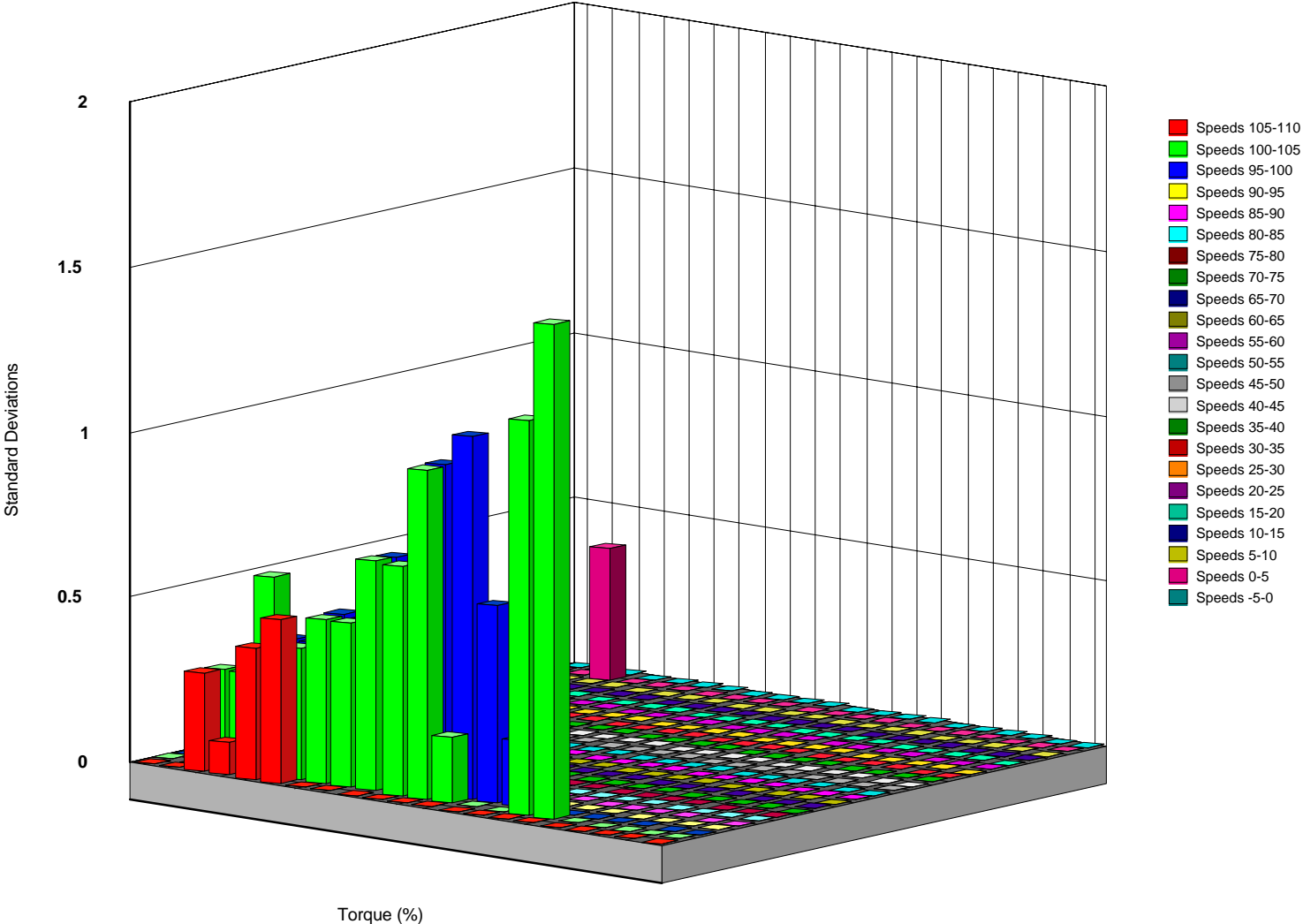


## WELDER HIGH TORQUE TRANSIENT--Speed Steady State Means

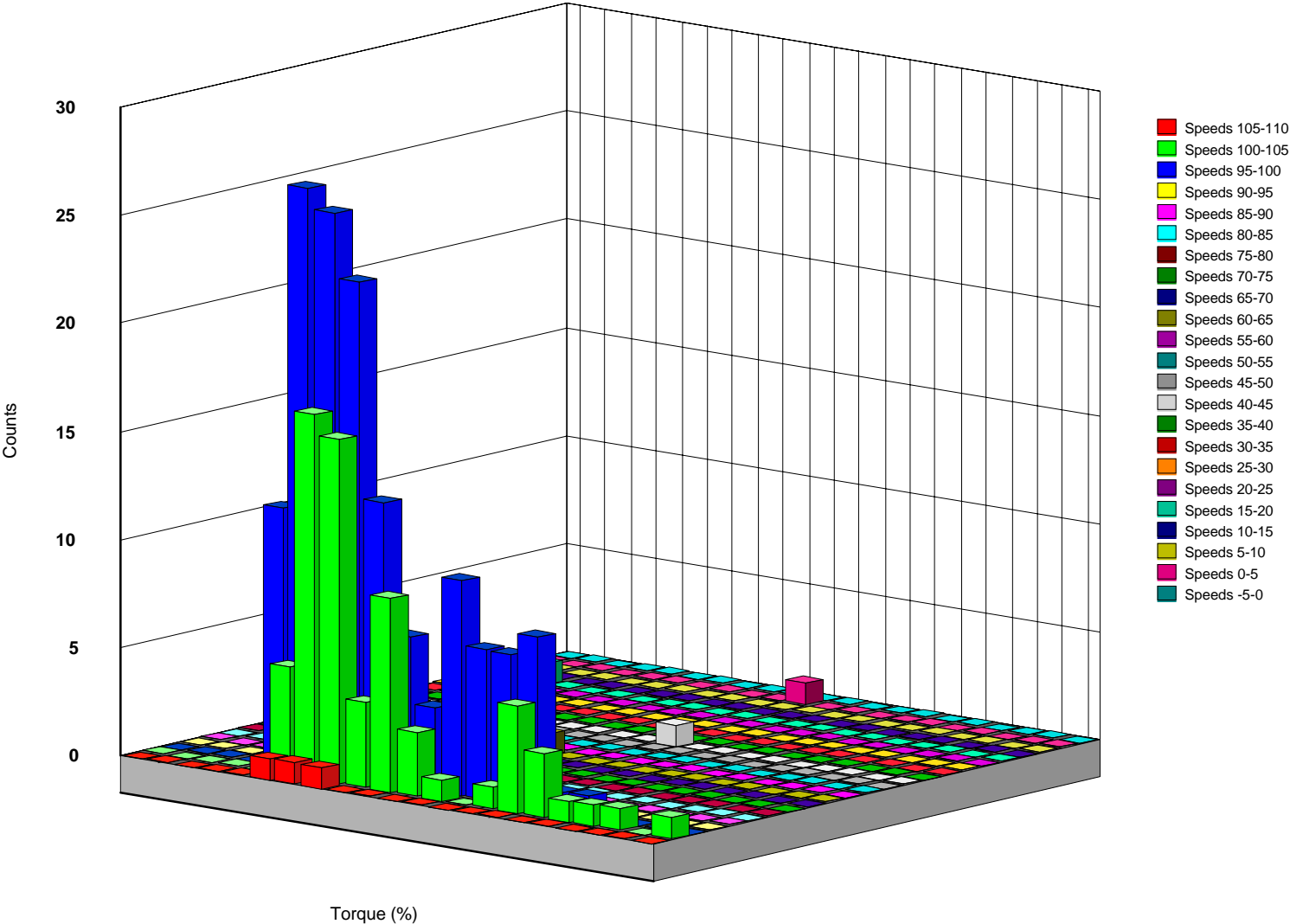




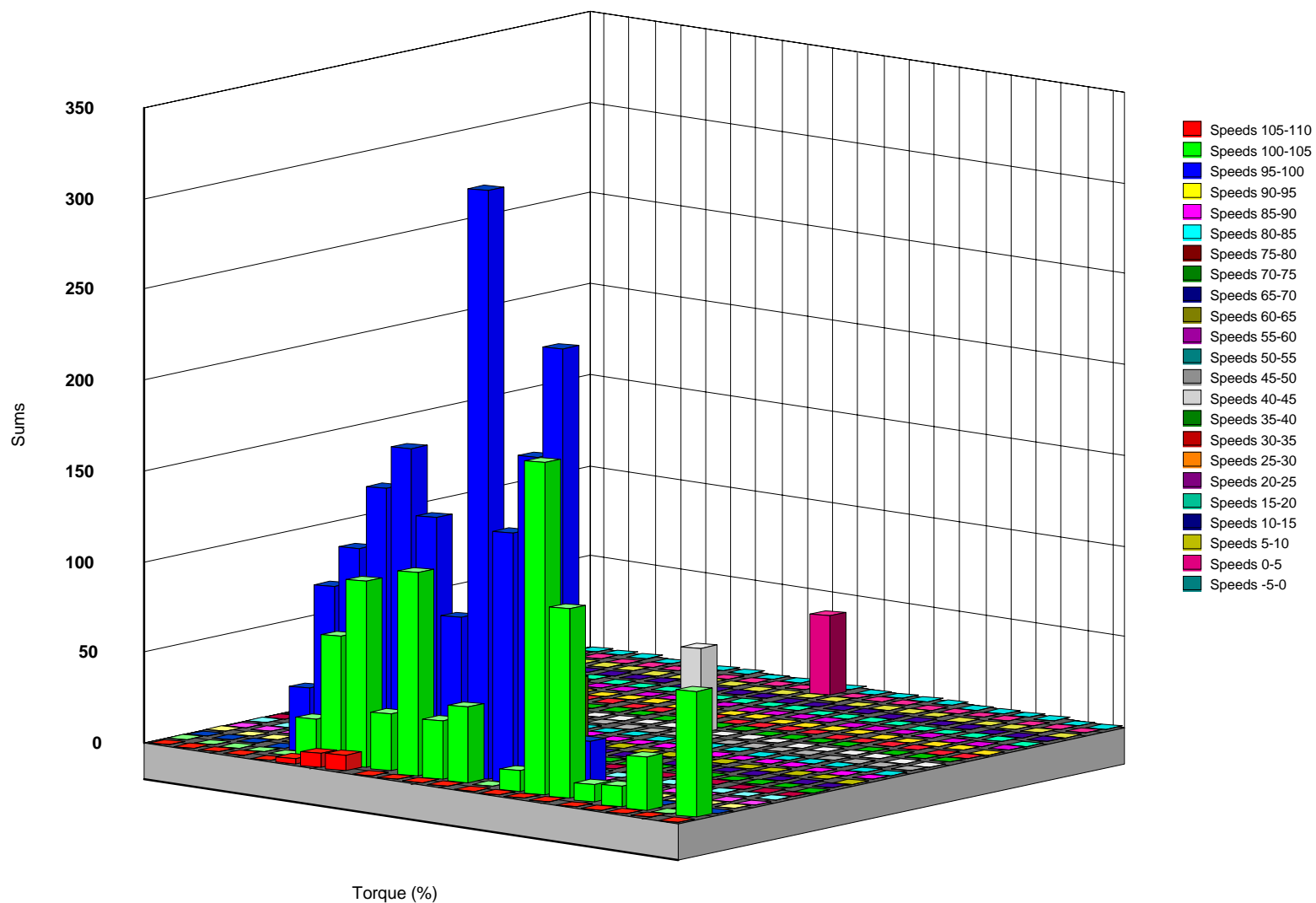
## WELDER HIGH TORQUE TRANSIENT--Speed Steady State Standard Deviations



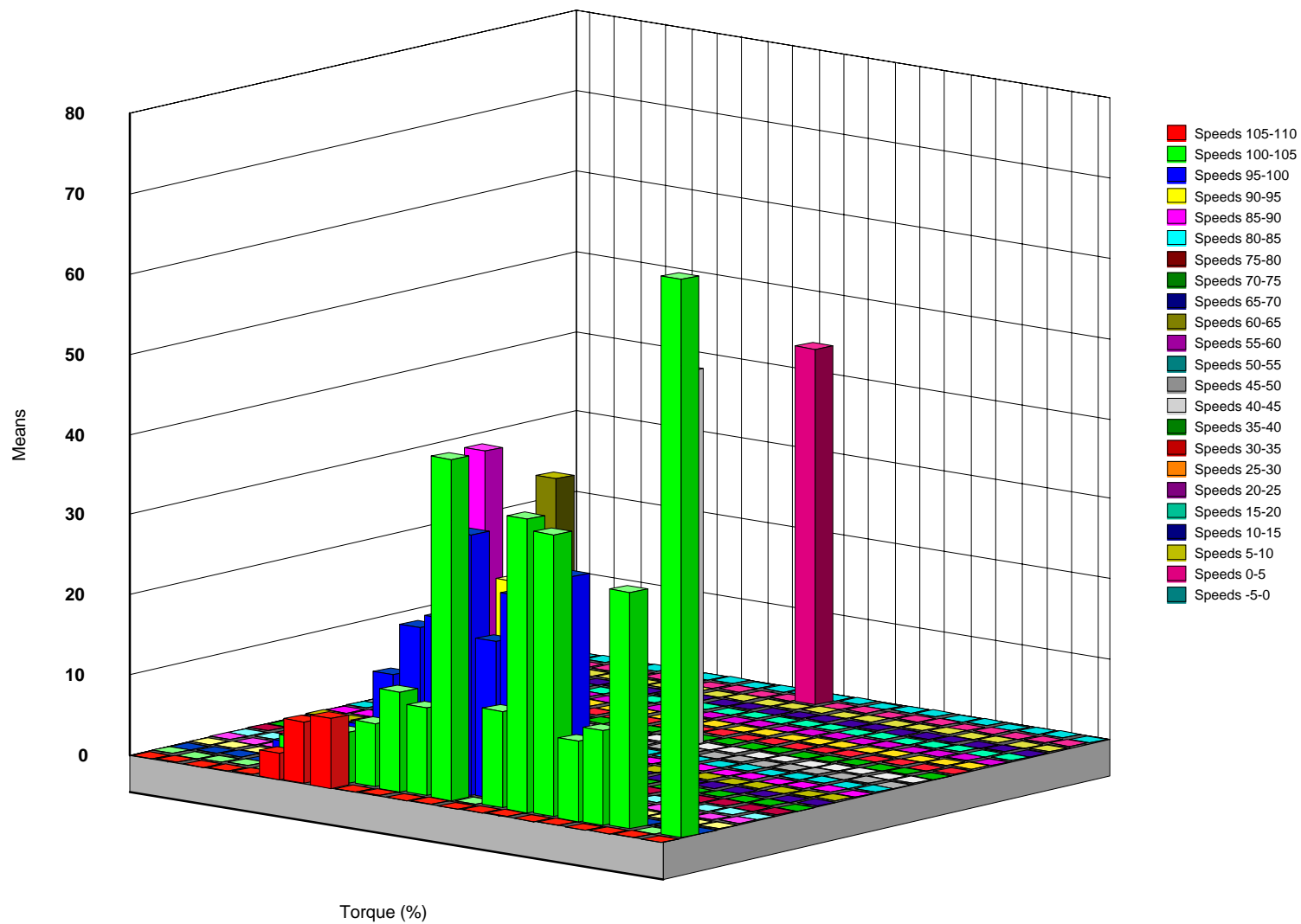
WELDER HIGH TORQUE TRANSIENT--Torque Acceleration Counts



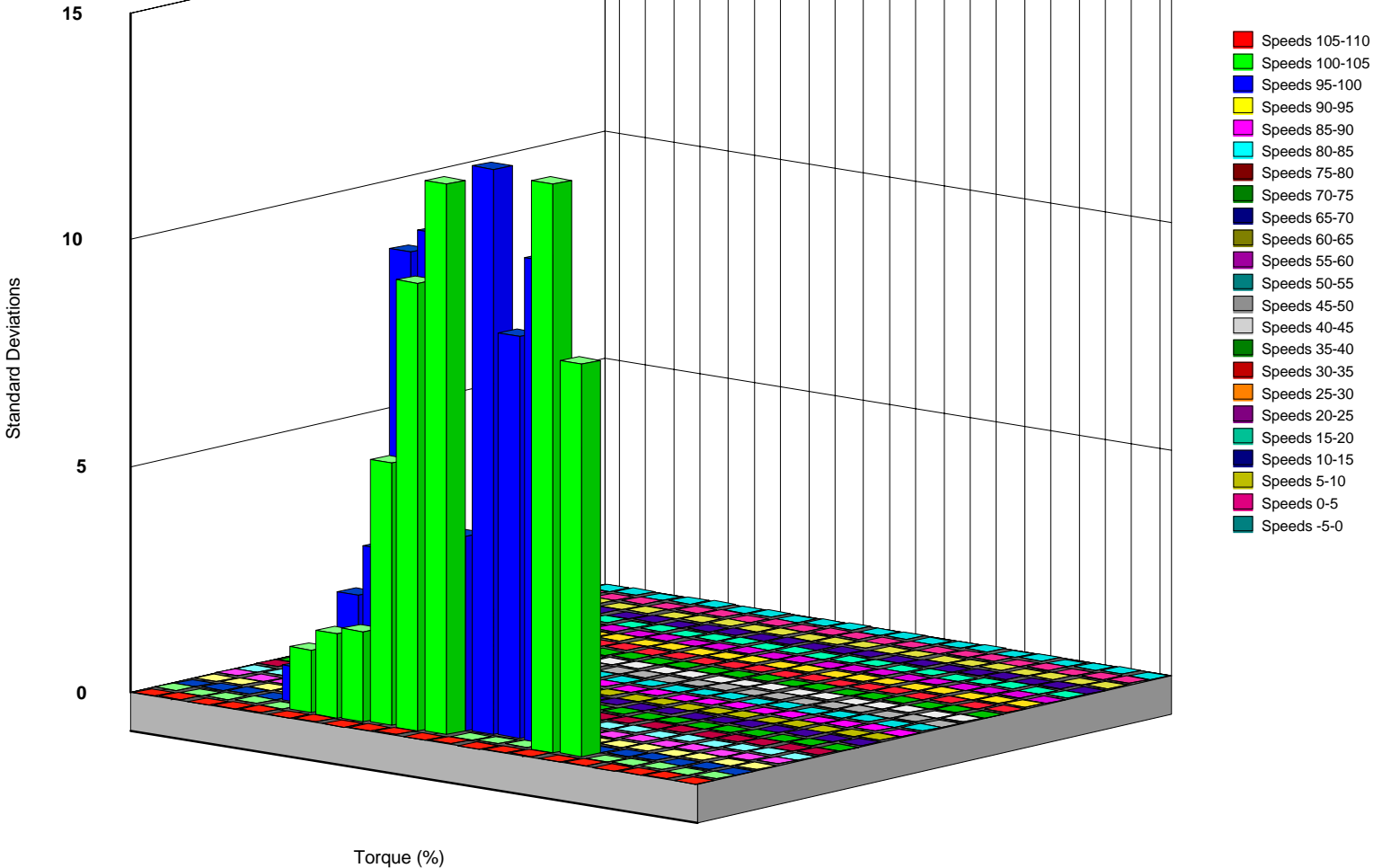
## WELDER HIGH TORQUE TRANSIENT--Torque Acceleration Sums



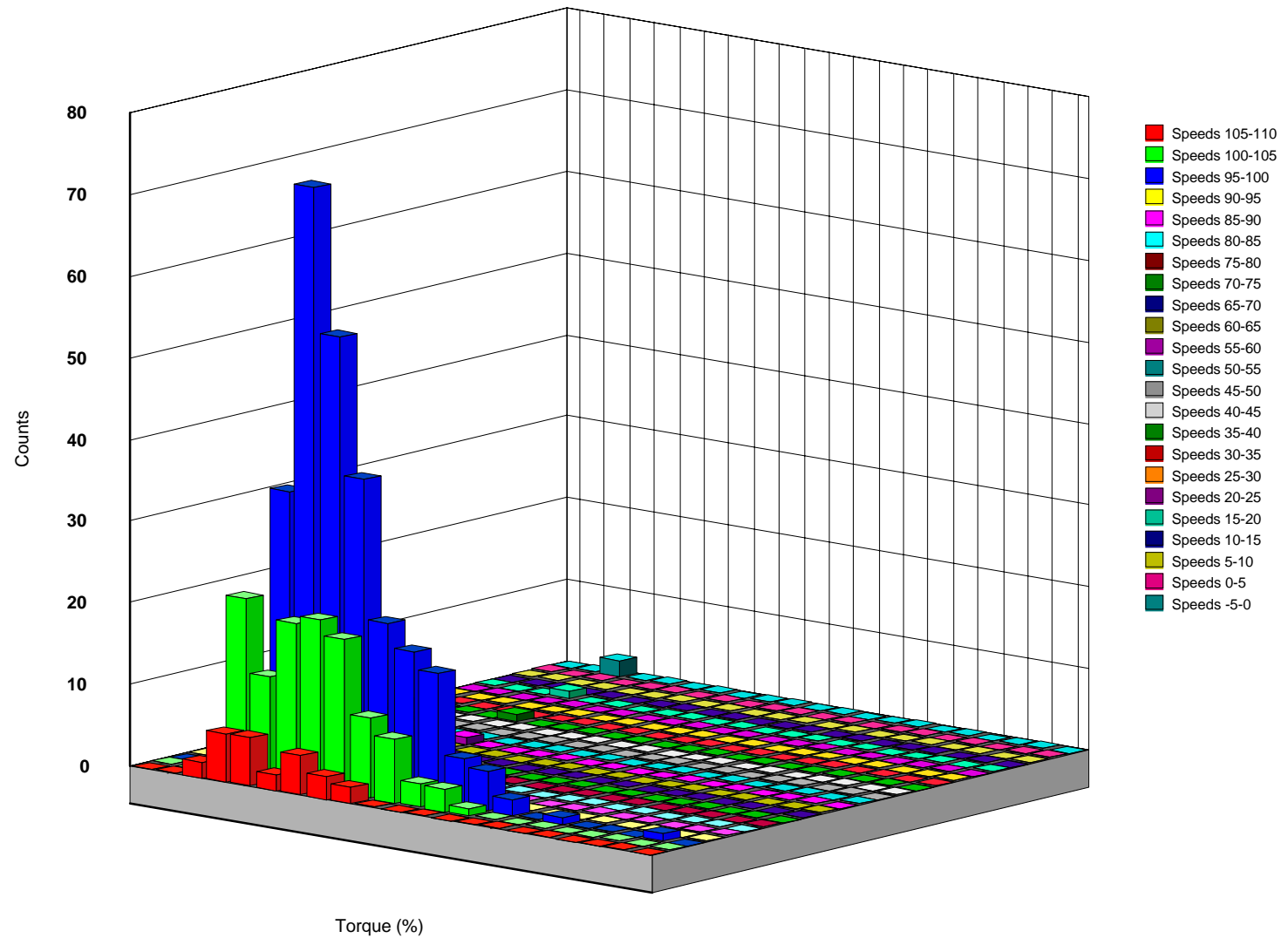
## WELDER HIGH TORQUE TRANSIENT--Torque Acceleration Means



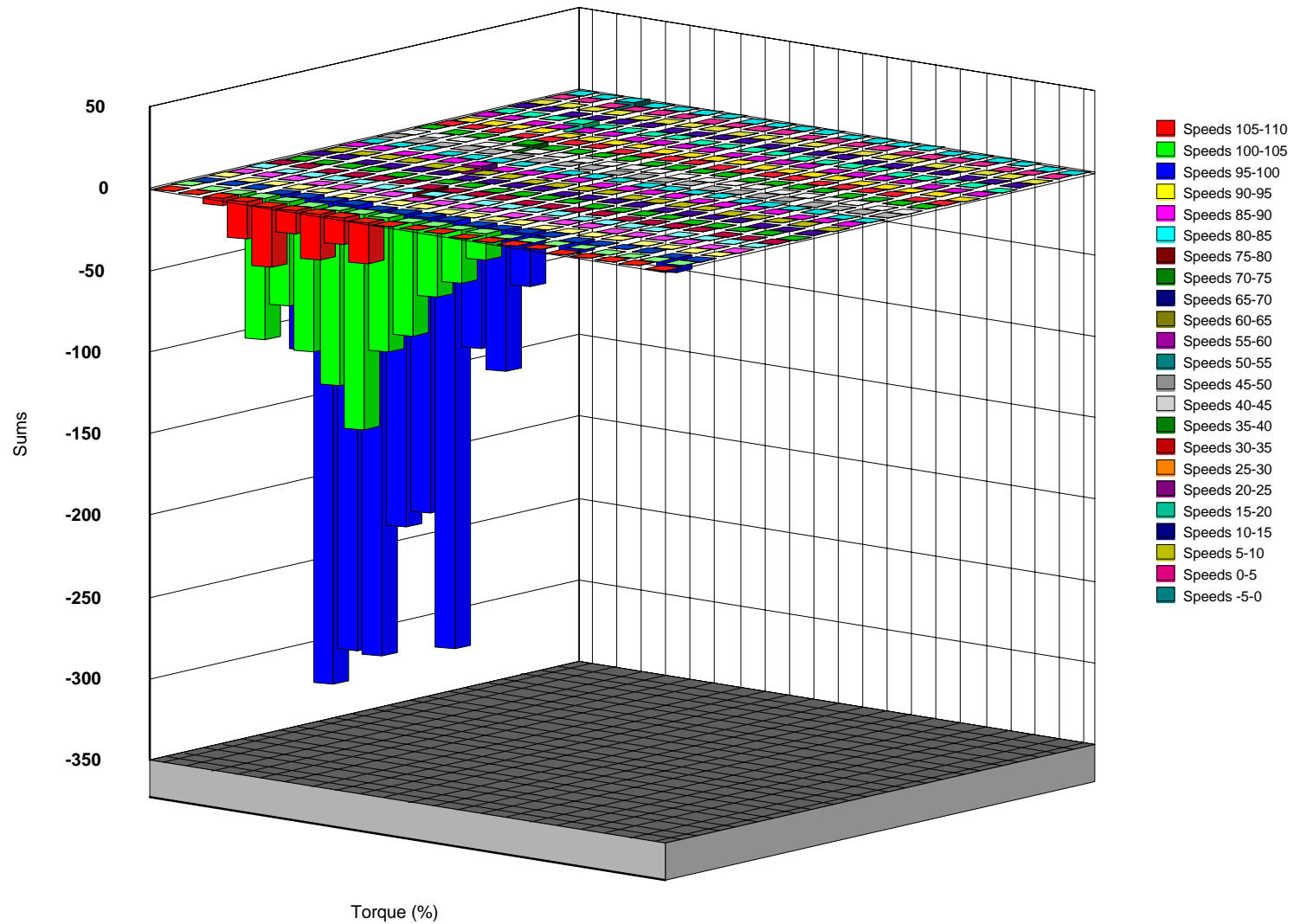
## WELDER HIGH TORQUE TRANSIENT--Torque Acceleration Standard Deviations



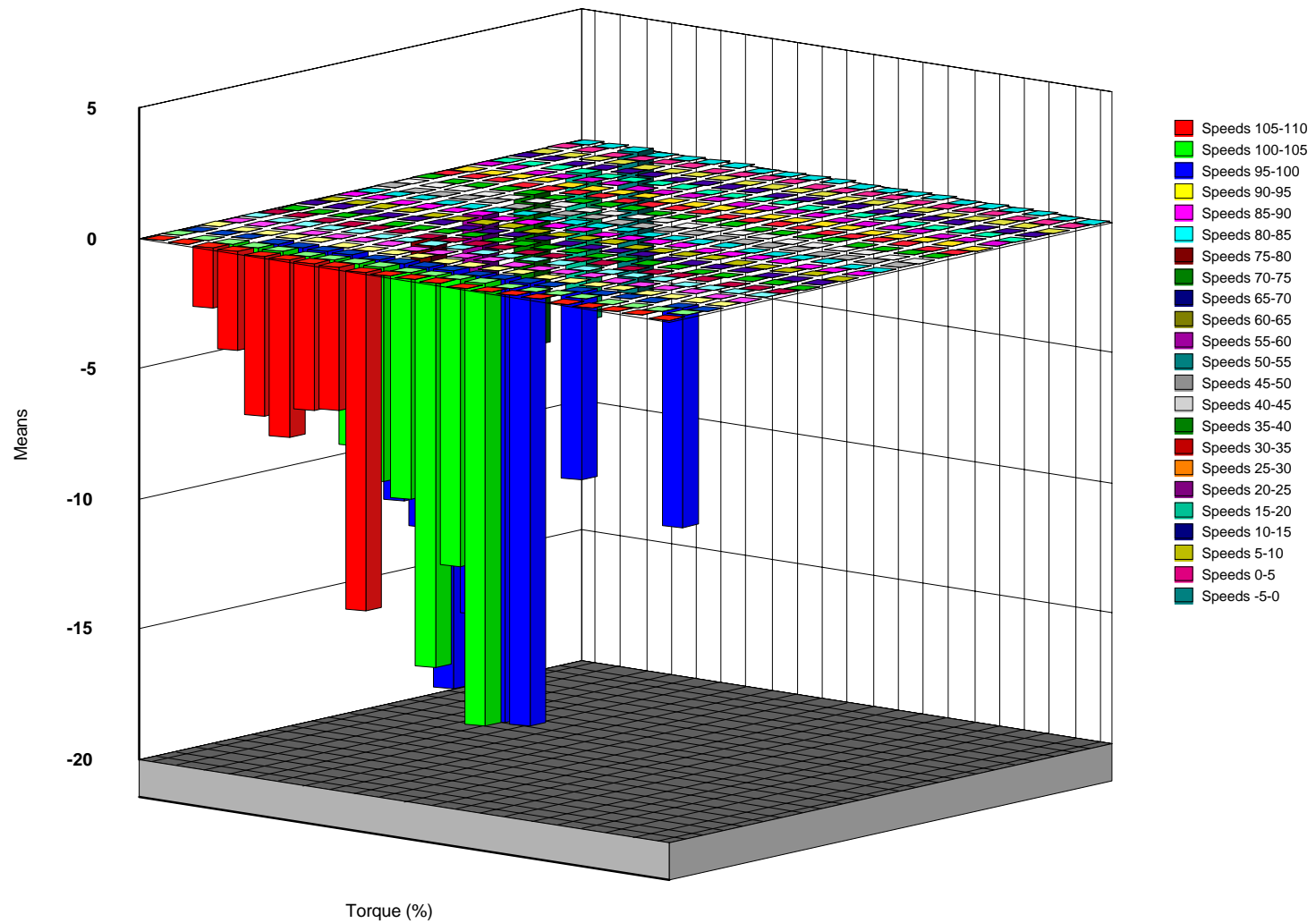
## WELDER HIGH TORQUE TRANSIENT--Torque Deceleration Counts



## WELDER HIGH TORQUE TRANSIENT--Torque Deceleration Sums

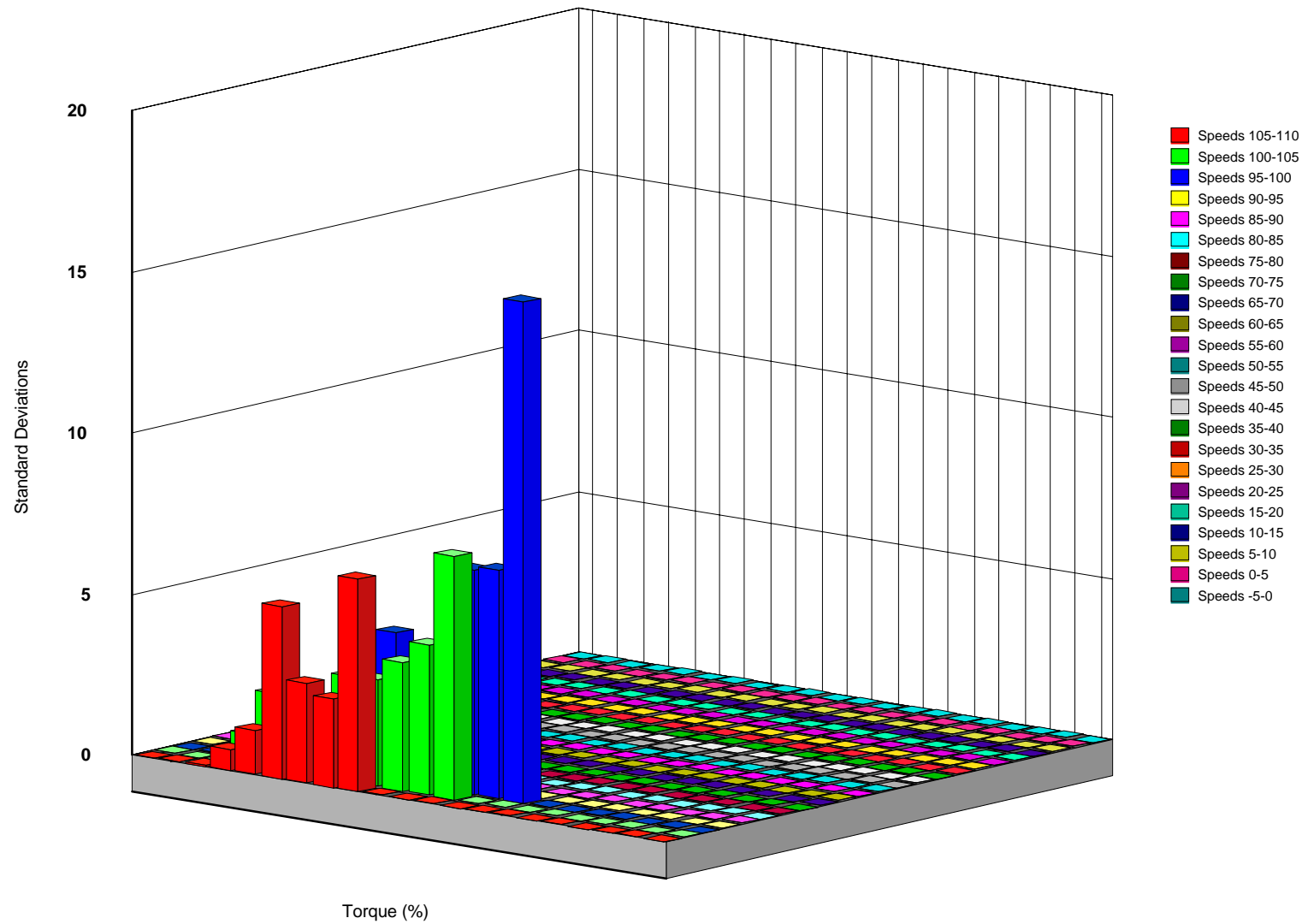


## WELDER HIGH TORQUE TRANSIENT--Torque Deceleration Means

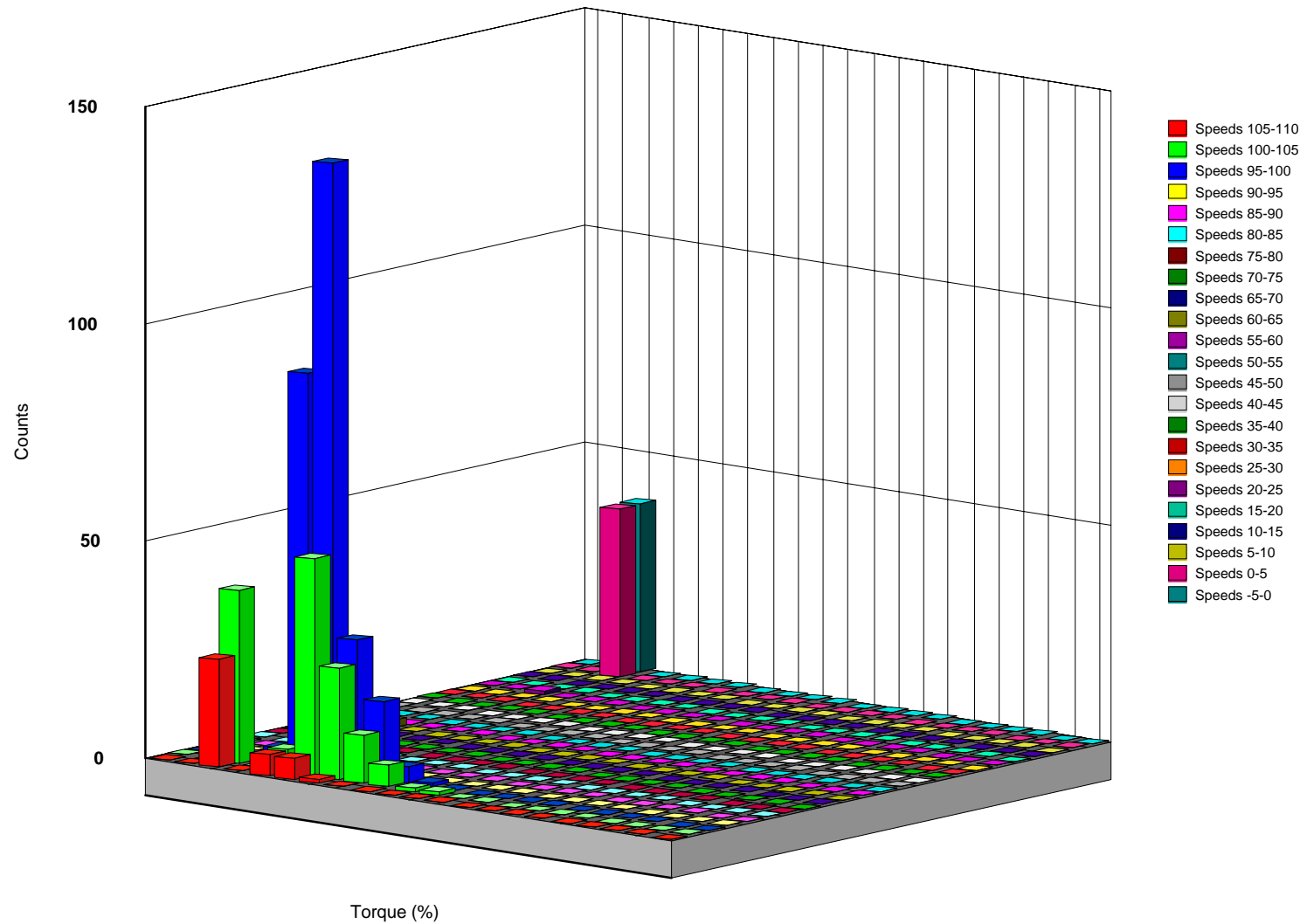




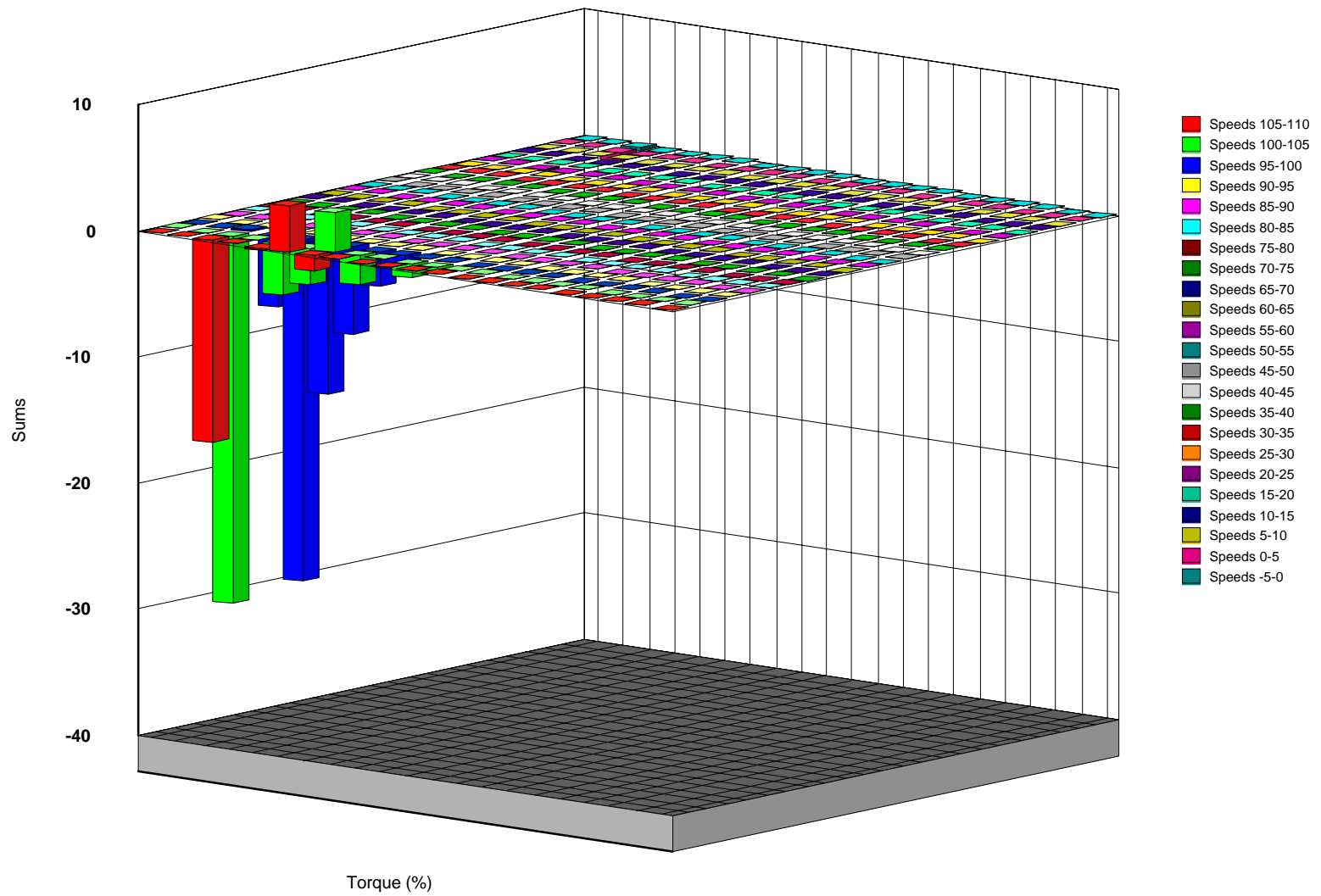
## WELDER HIGH TORQUE TRANSIENT--Torque Deceleration Standard Deviations



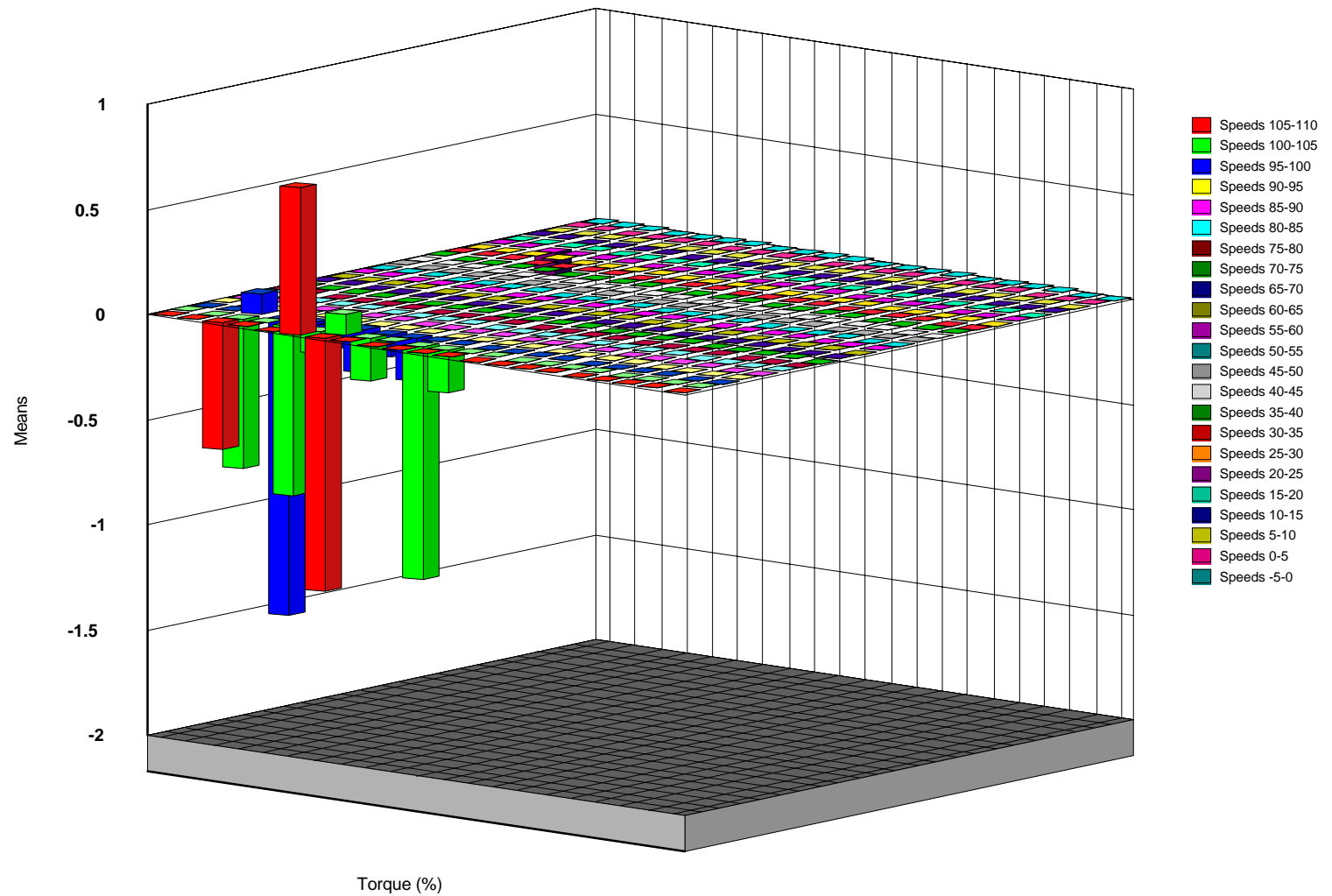
## WELDER HIGH TORQUE TRANSIENT--Torque Steady State Counts



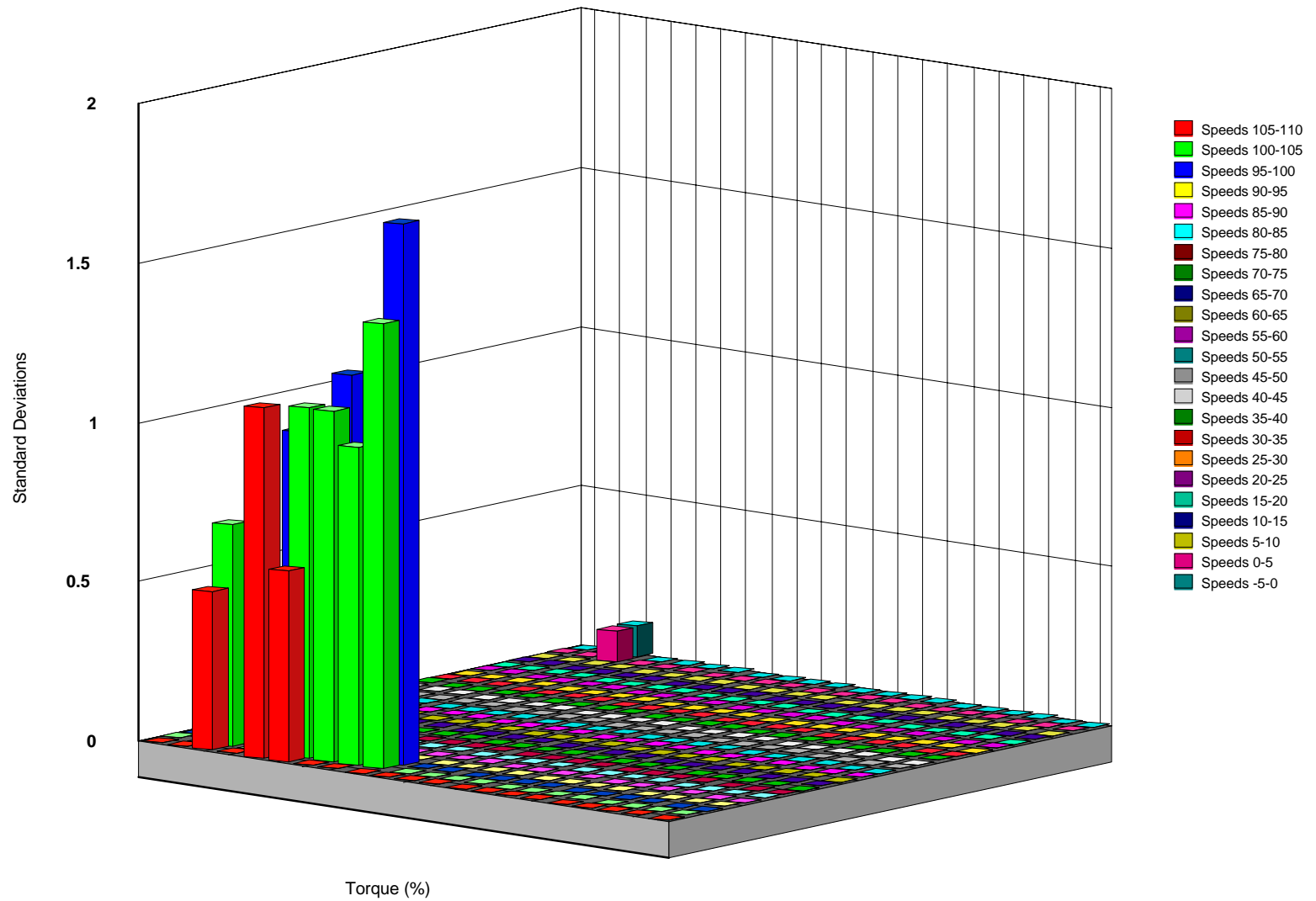
## WELDER HIGH TORQUE TRANSIENT--Torque Steady State Sums



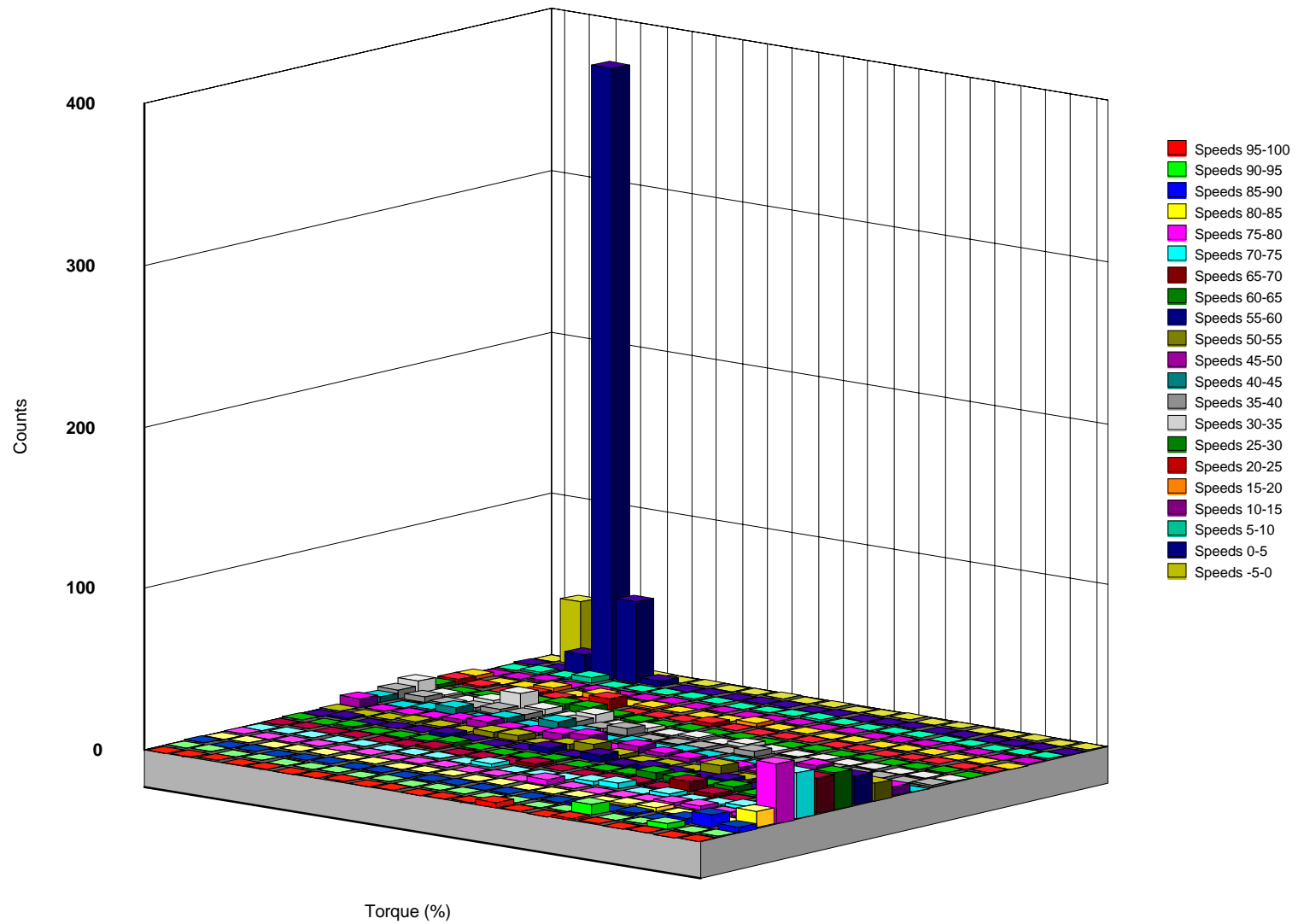
## WELDER HIGH TORQUE TRANSIENT--Torque Steady State Means



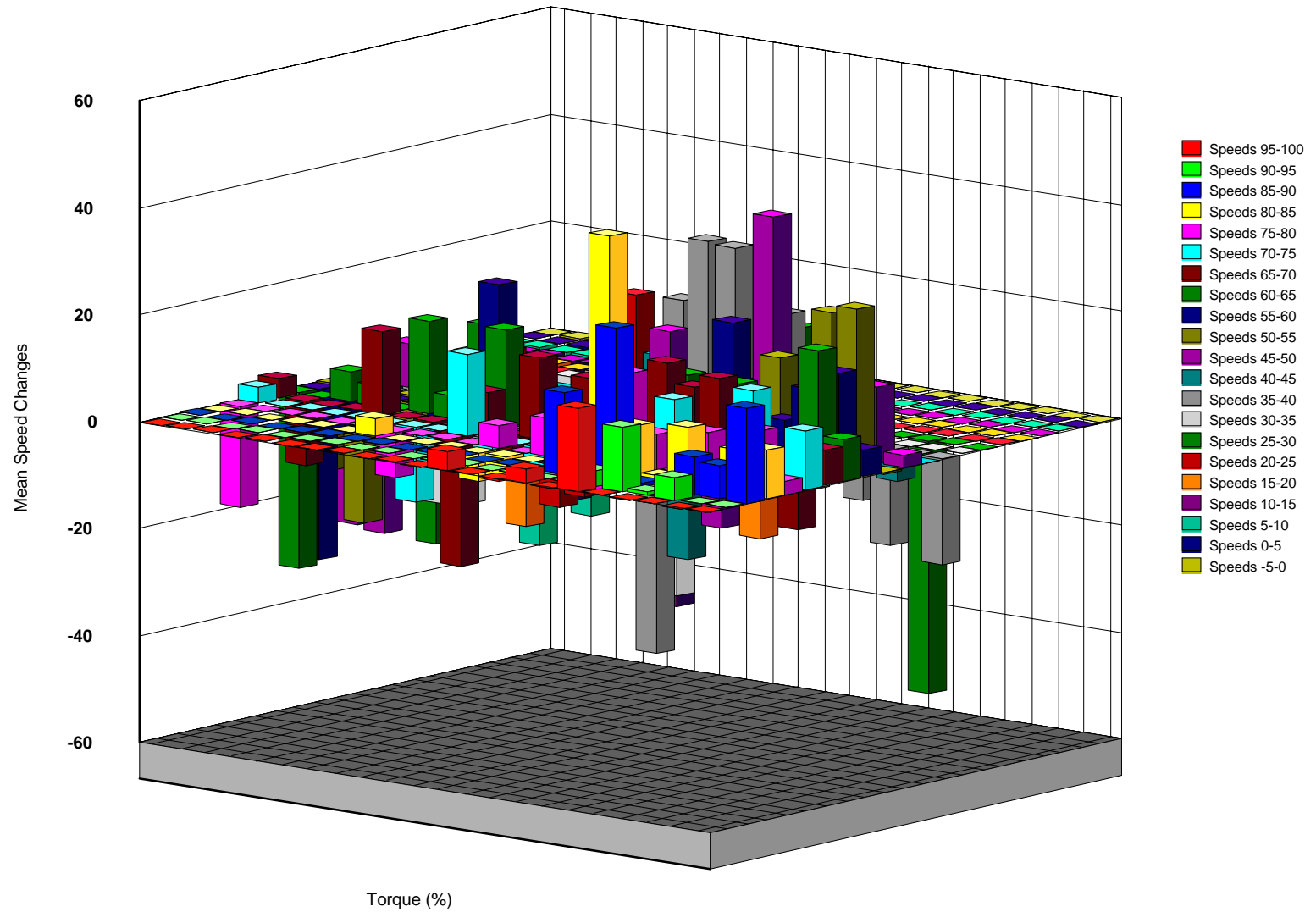
## WELDER HIGH TORQUE TRANSIENT--Torque Steady State Standard Deviations



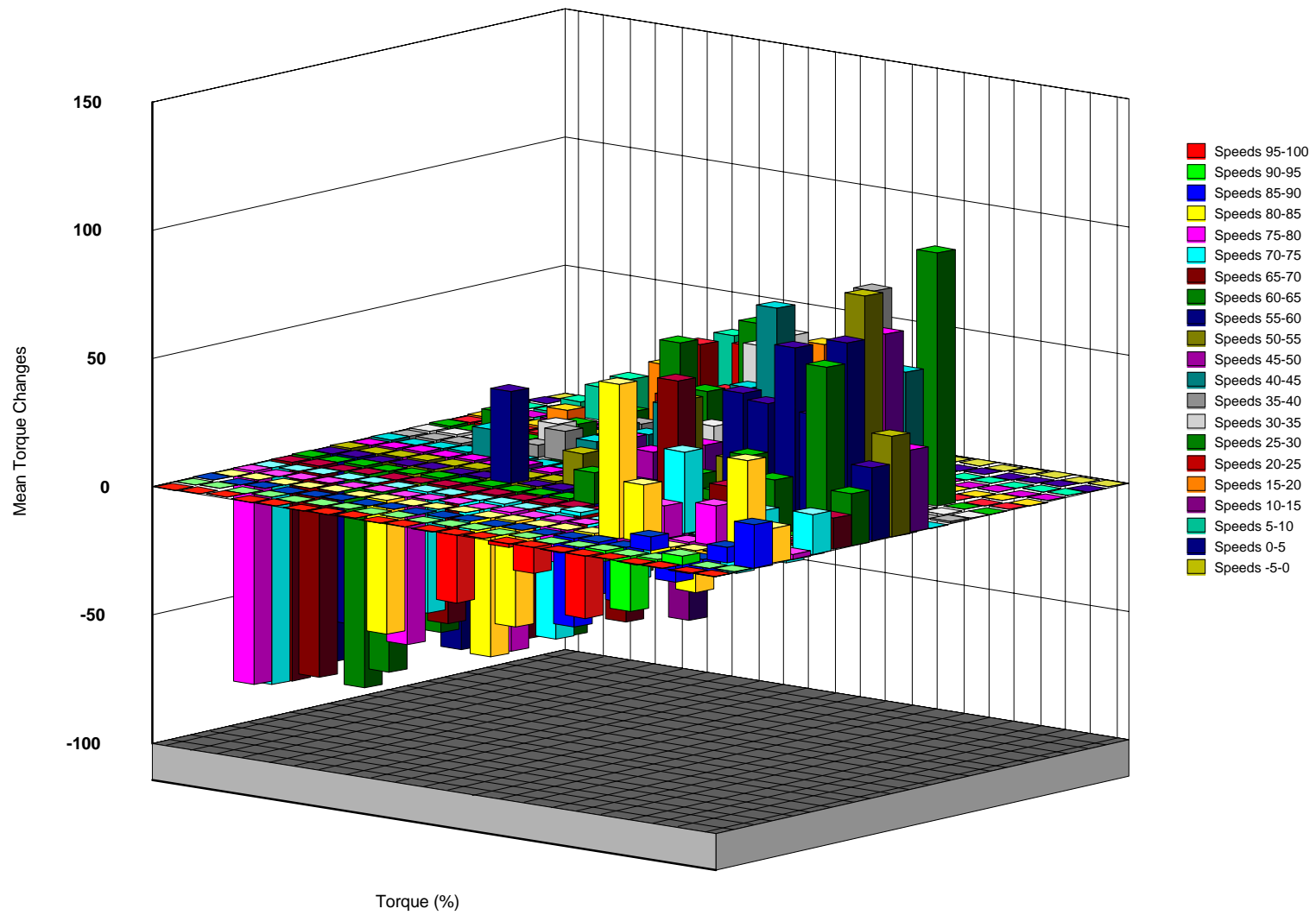
## WHEEL LOADER TYPICAL 1--Counts



# WHEEL LOADER TYPICAL 1--Mean Speed Changes

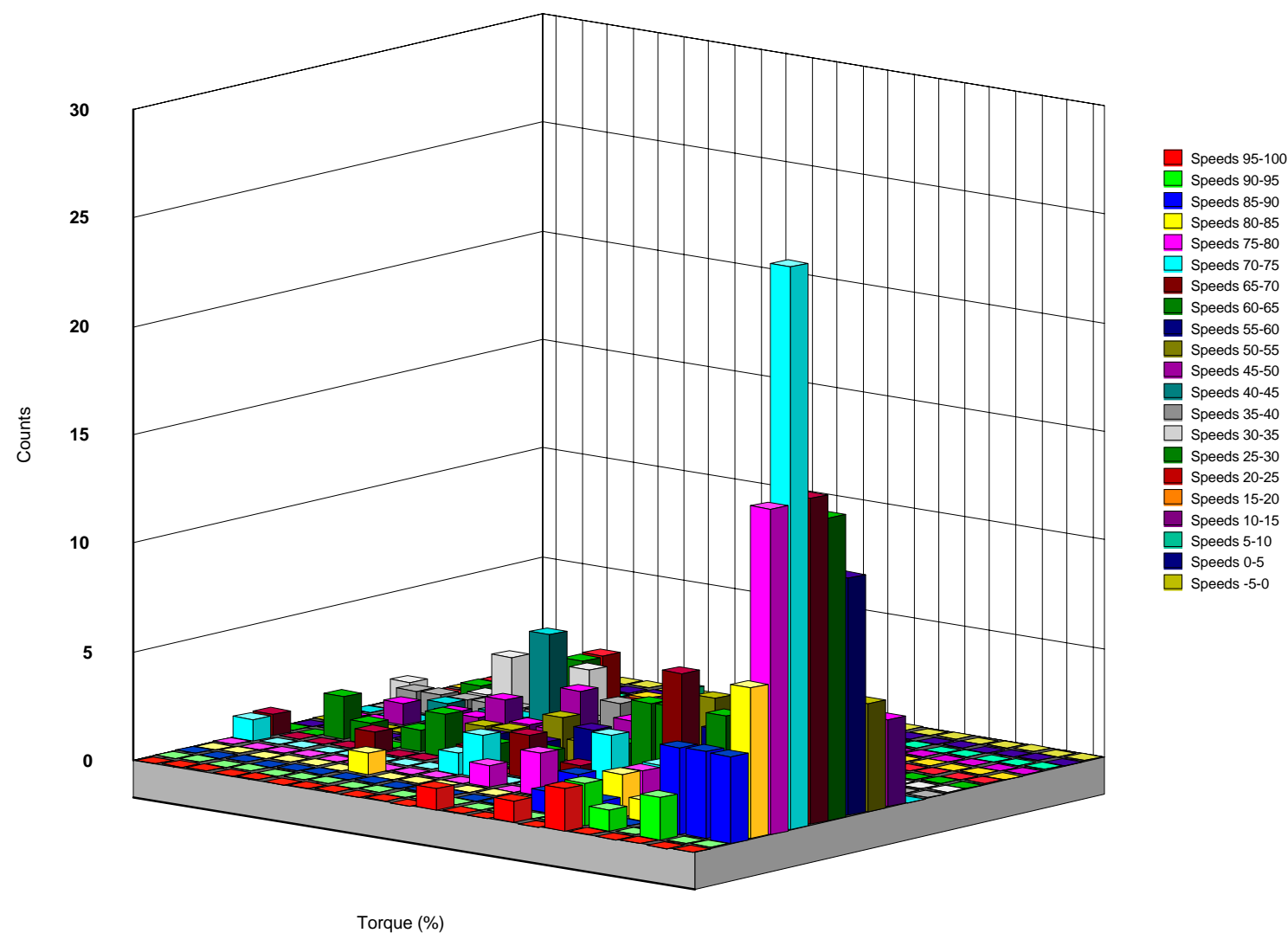


WHEEL LOADER TYPICAL 1--Mean Torque Changes

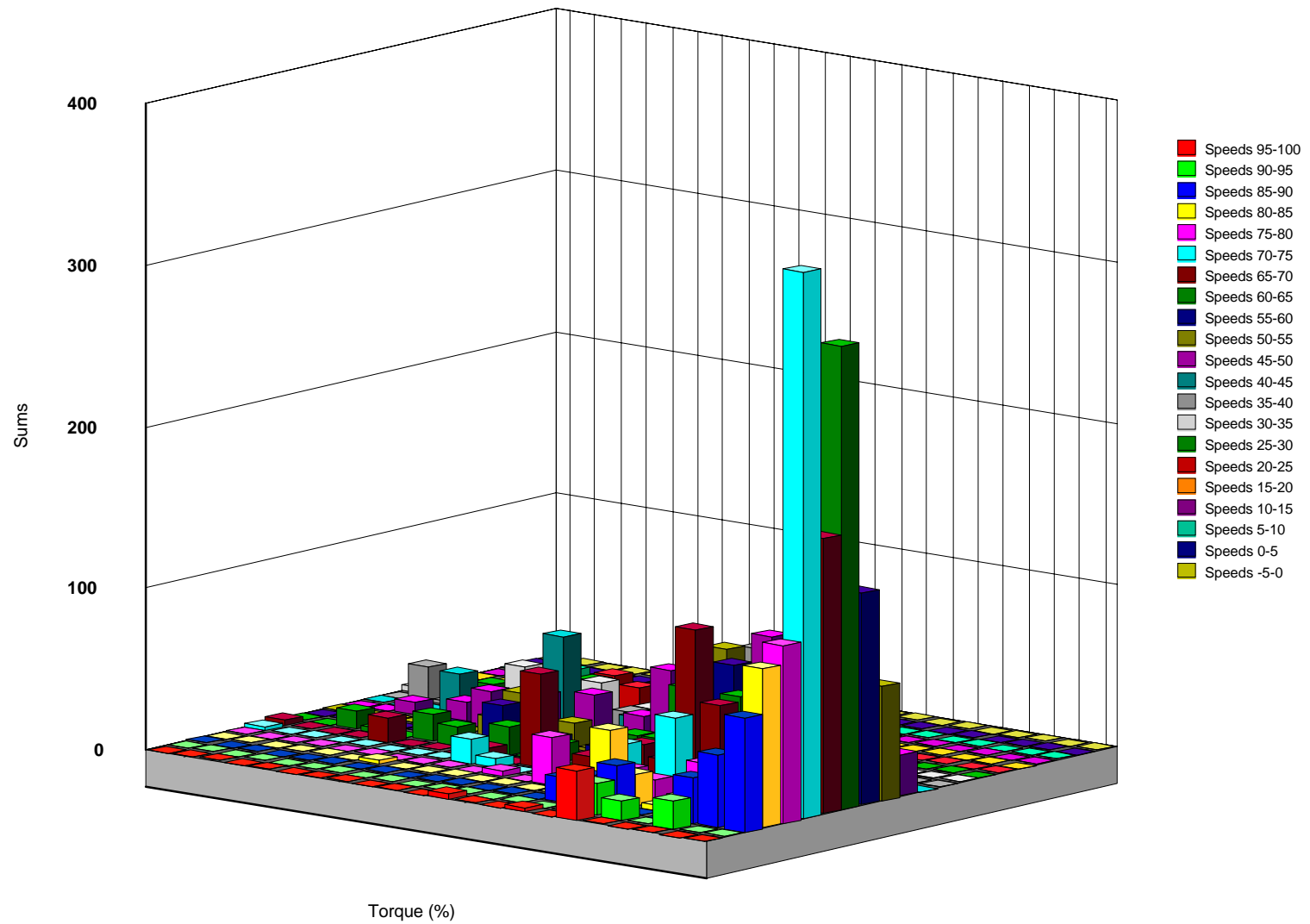




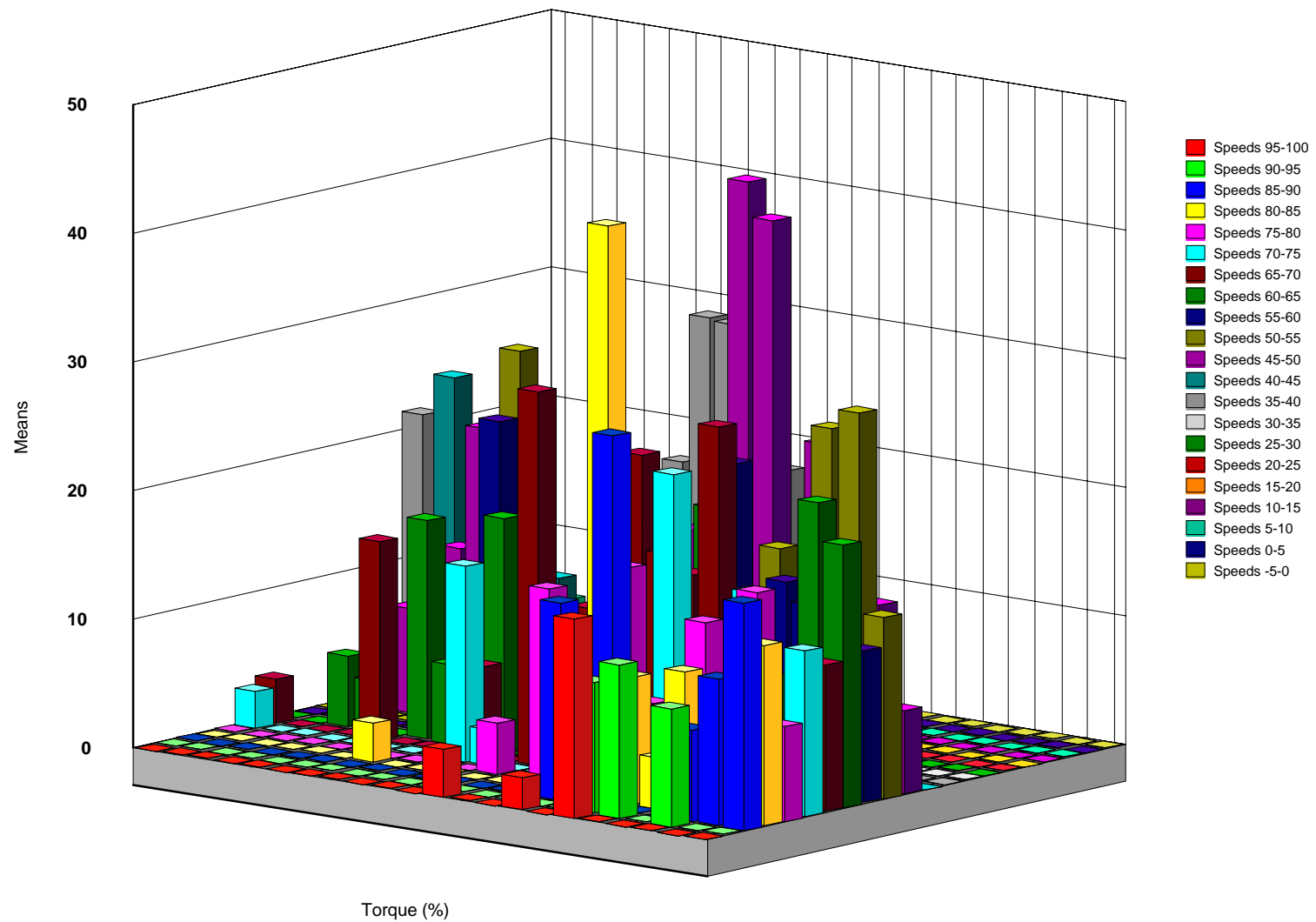
WHEEL LOADER TYPICAL 1--Speed Acceleration Counts



## WHEEL LOADER TYPICAL 1--Speed Acceleration Sums



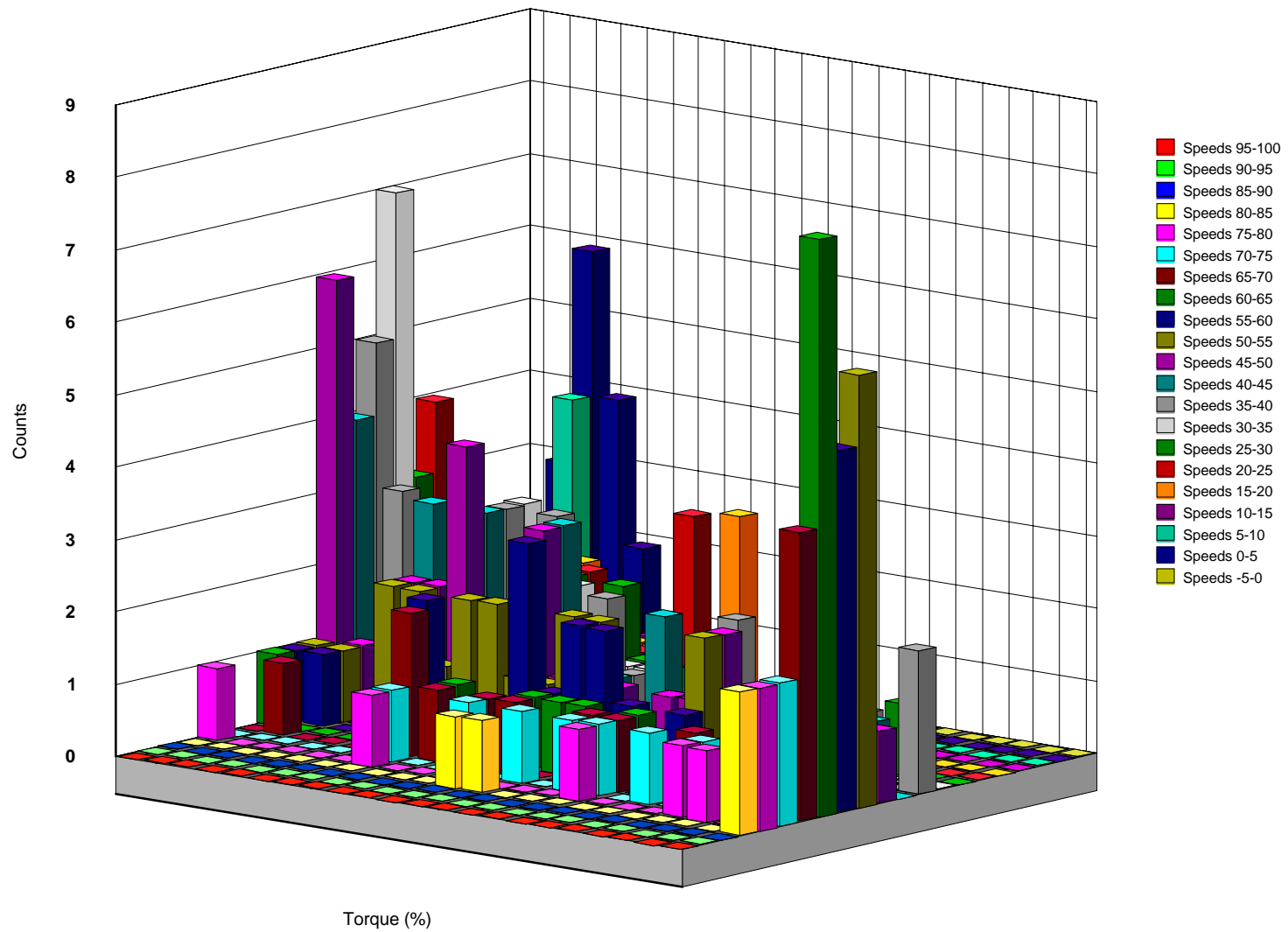
## WHEEL LOADER TYPICAL 1--Speed Acceleration Means



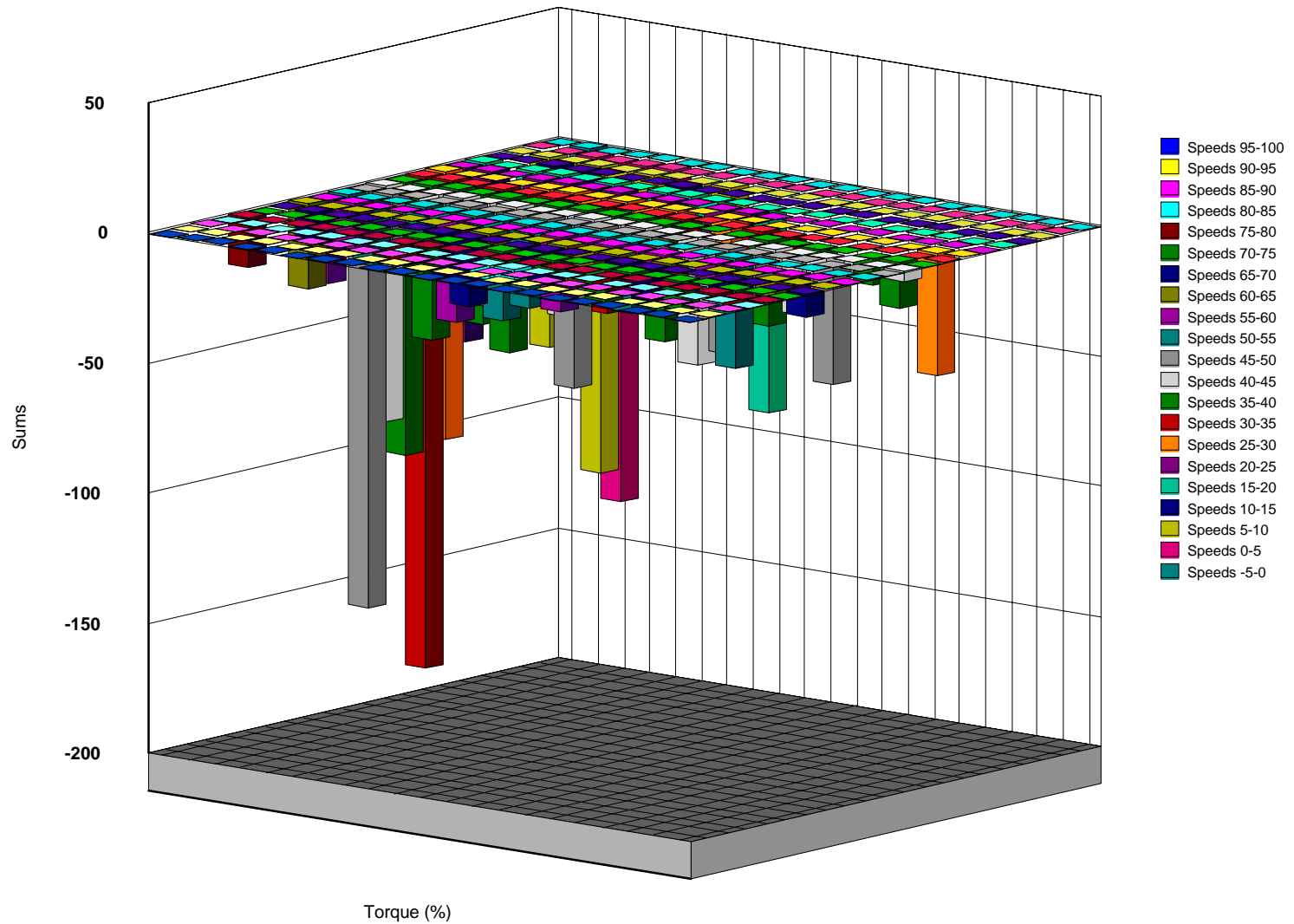
A 3D bar chart visualization. The base is a grid of small, multi-colored squares. The chart contains approximately 25 bars of varying heights and colors, including red, green, blue, yellow, cyan, magenta, brown, and grey. The tallest bar is a dark red one located towards the back right. The chart is set within a 3D coordinate system with a grid of vertical and horizontal lines in the background.

- Speeds 95-100
- Speeds 90-95
- Speeds 85-90
- Speeds 80-85
- Speeds 75-80
- Speeds 70-75
- Speeds 65-70
- Speeds 60-65
- Speeds 55-60
- Speeds 50-55
- Speeds 45-50
- Speeds 40-45
- Speeds 35-40
- Speeds 30-35
- Speeds 25-30
- Speeds 20-25
- Speeds 15-20
- Speeds 10-15
- Speeds 5-10
- Speeds 0-5
- Speeds -5-0

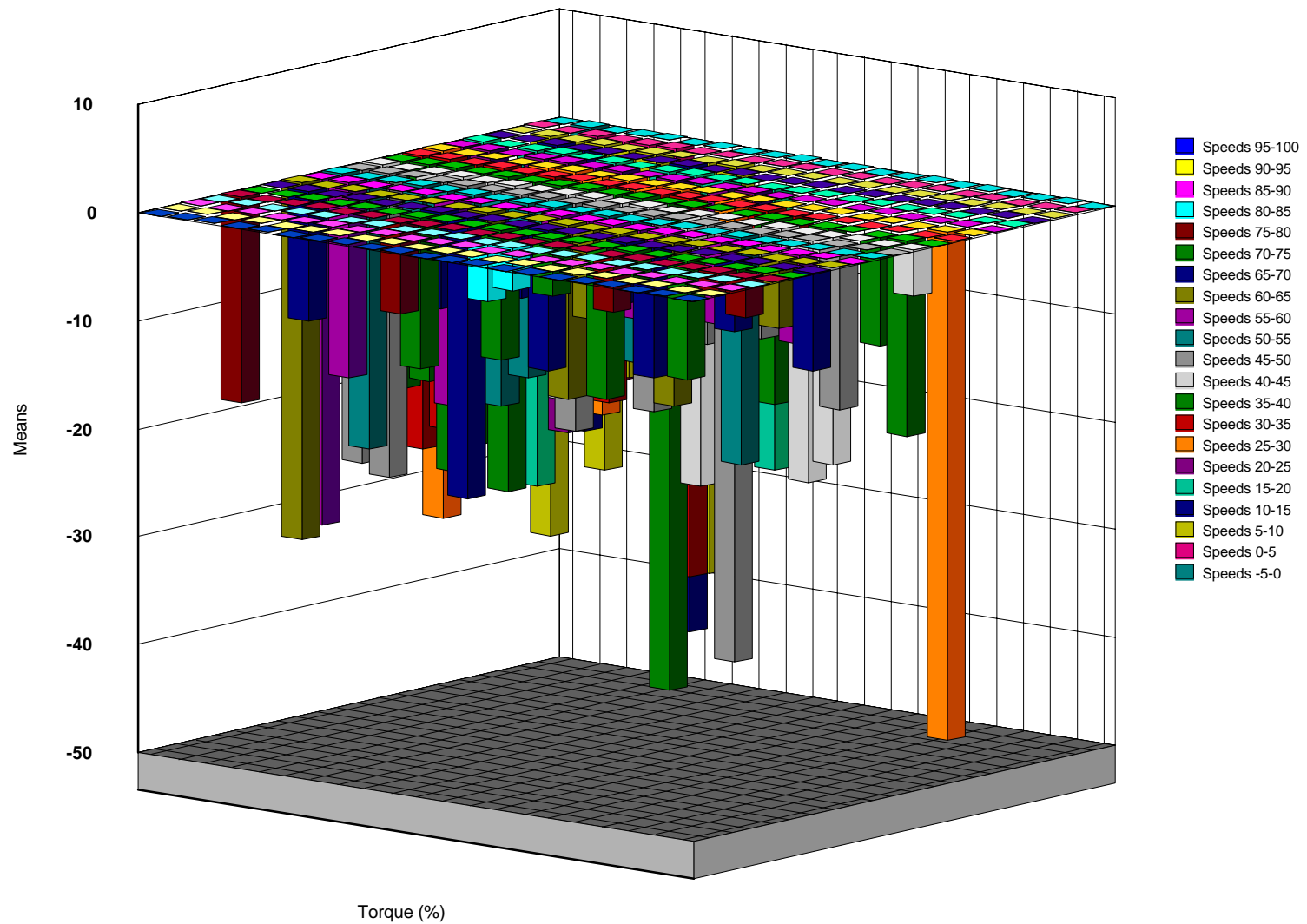
## WHEEL LOADER TYPICAL 1--Speed Deceleration Counts



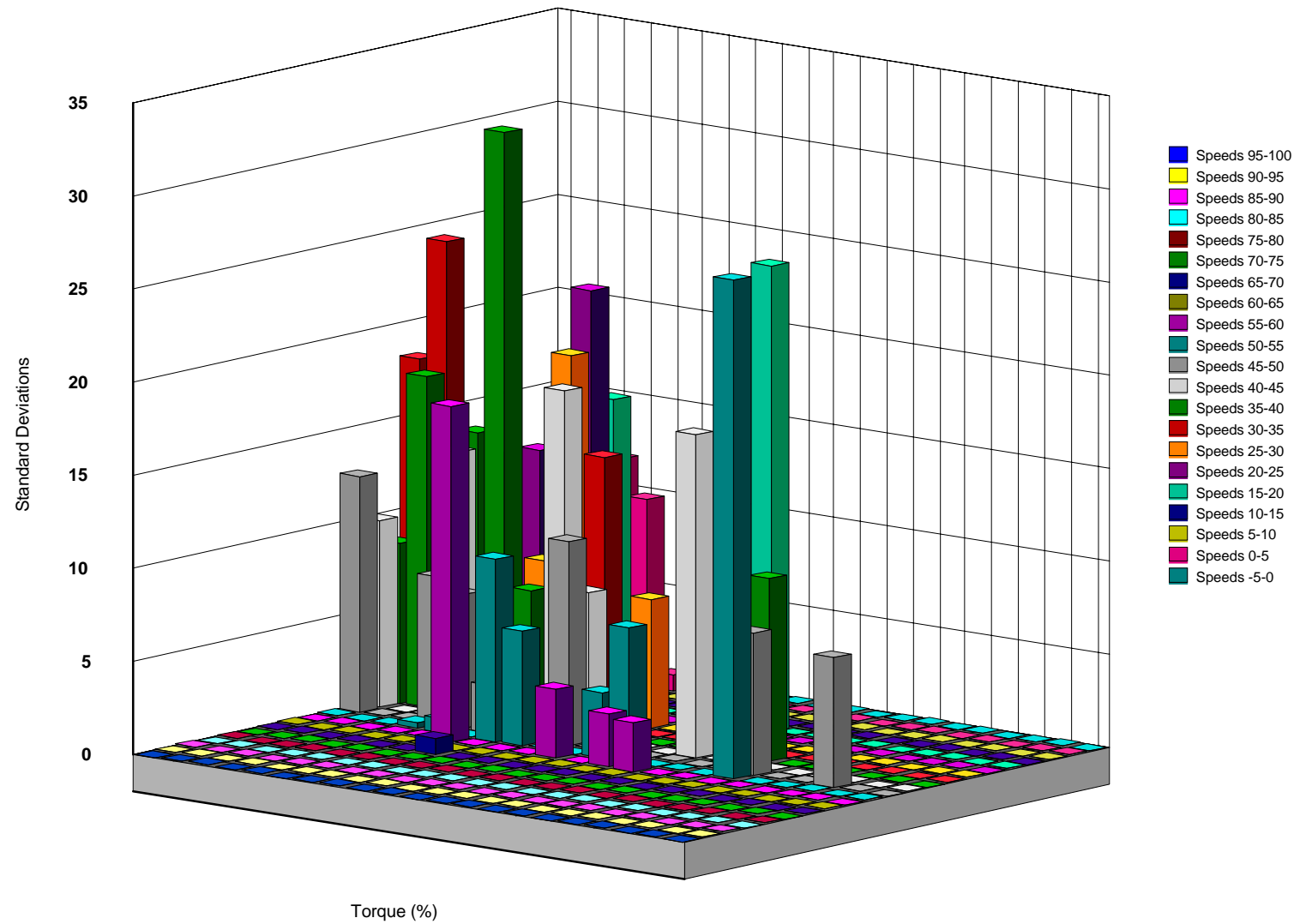
## WHEEL LOADER TYPICAL 1--Speed Deceleration Sums



## WHEEL LOADER TYPICAL 1--Speed Deceleration Means

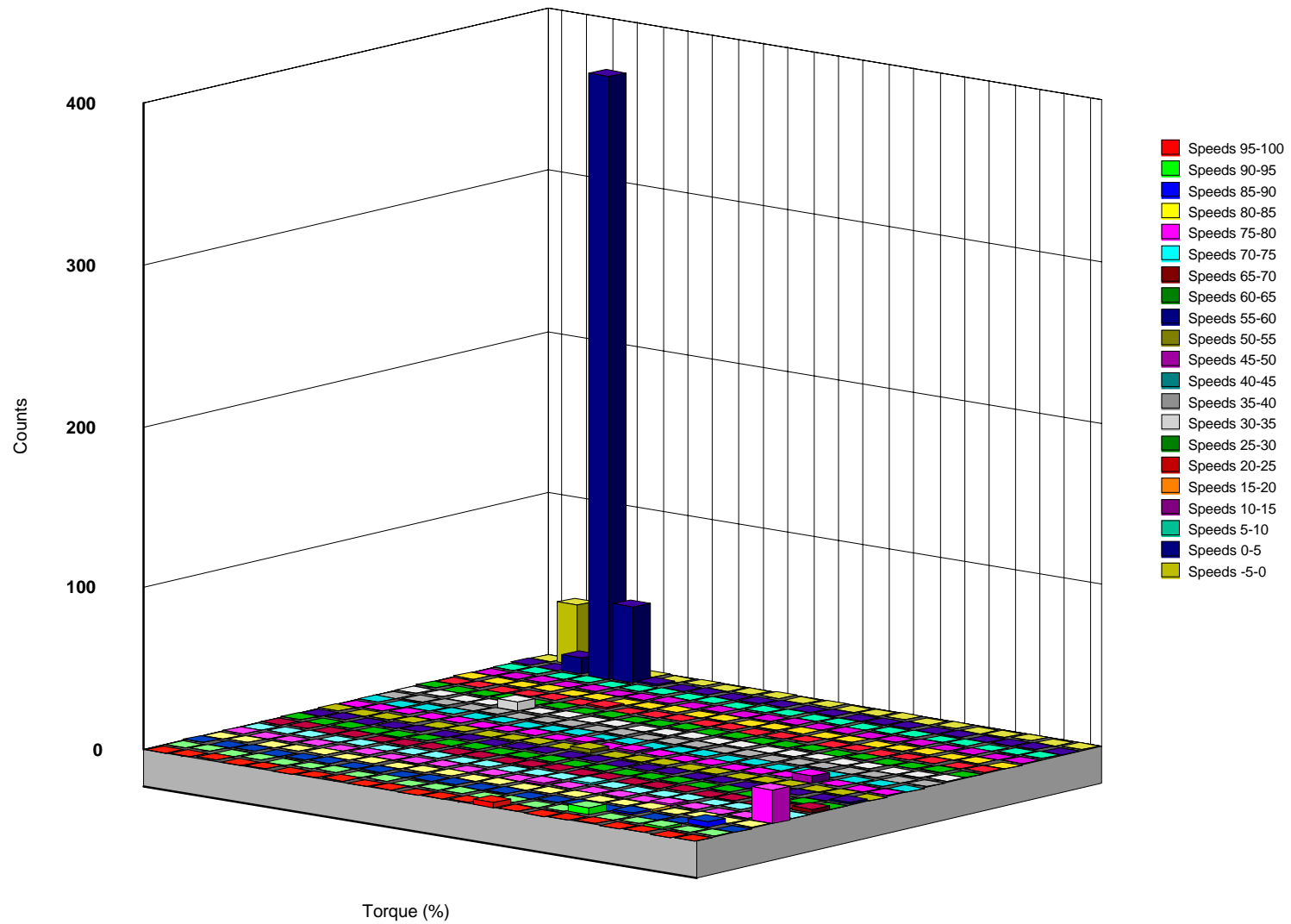


# WHEEL LOADER TYPICAL 1--Speed Deceleration Standard Deviations

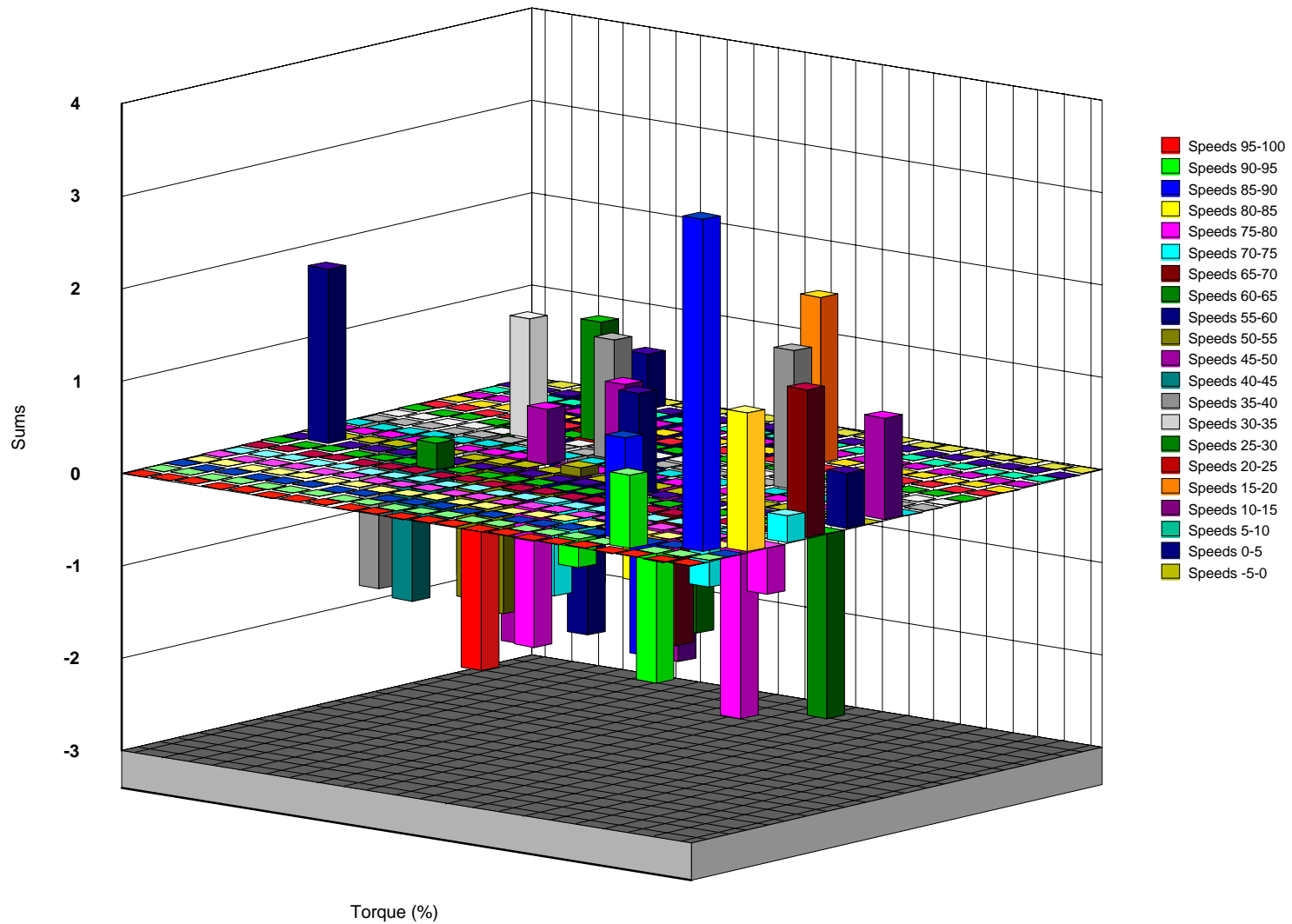




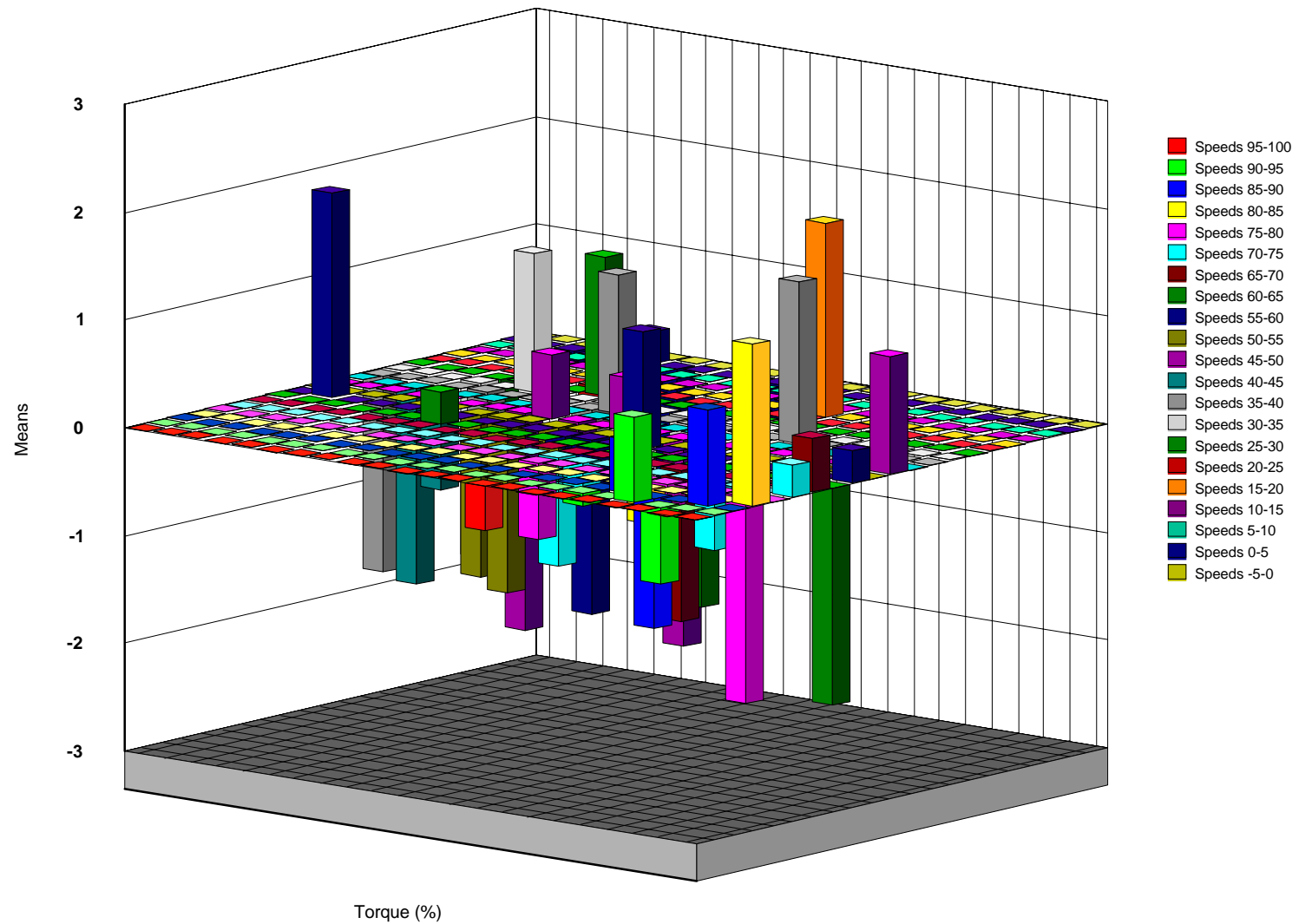
## WHEEL LOADER TYPICAL 1--Speed Steady State Counts



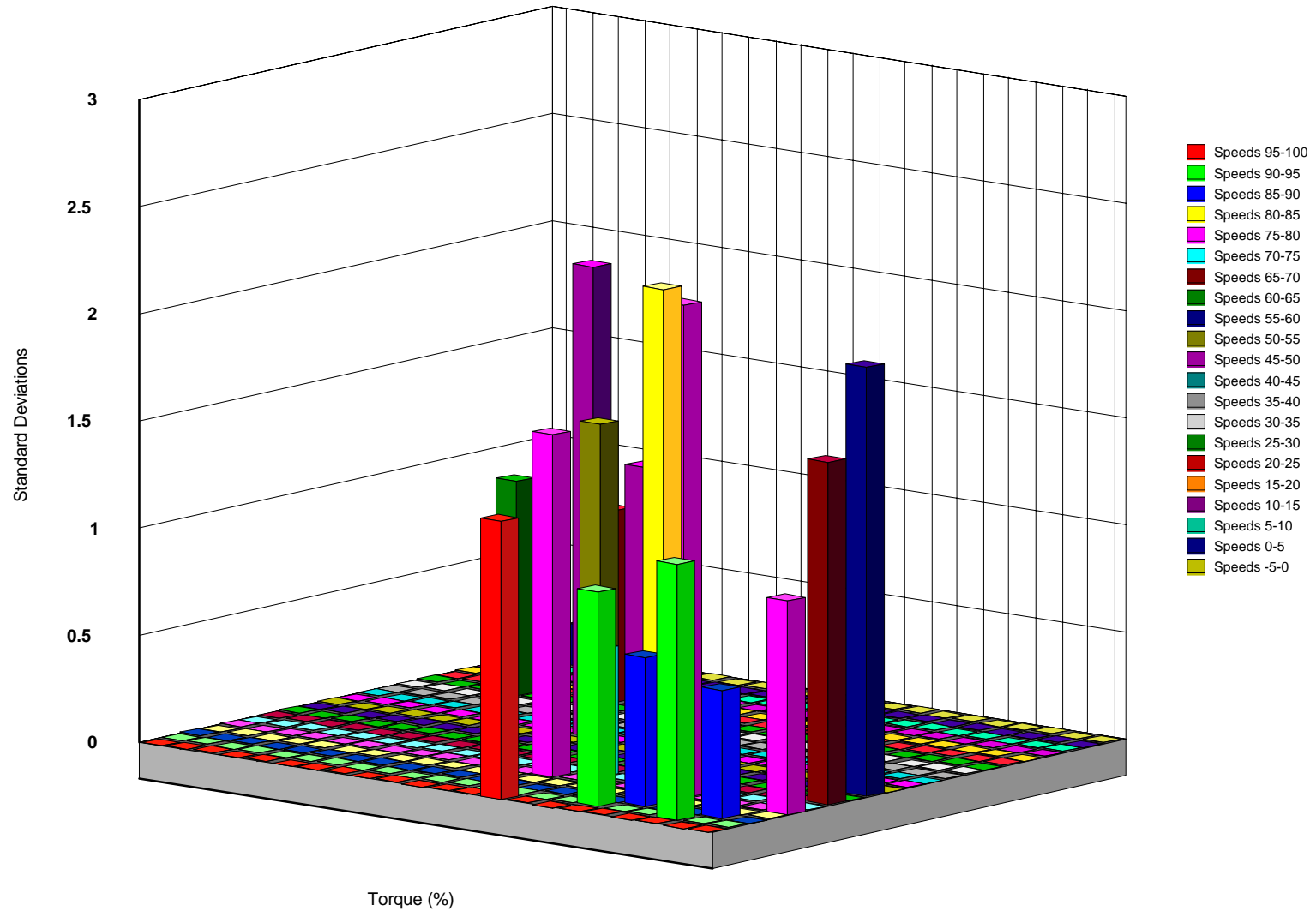
## WHEEL LOADER TYPICAL 1--Speed Steady State Sums



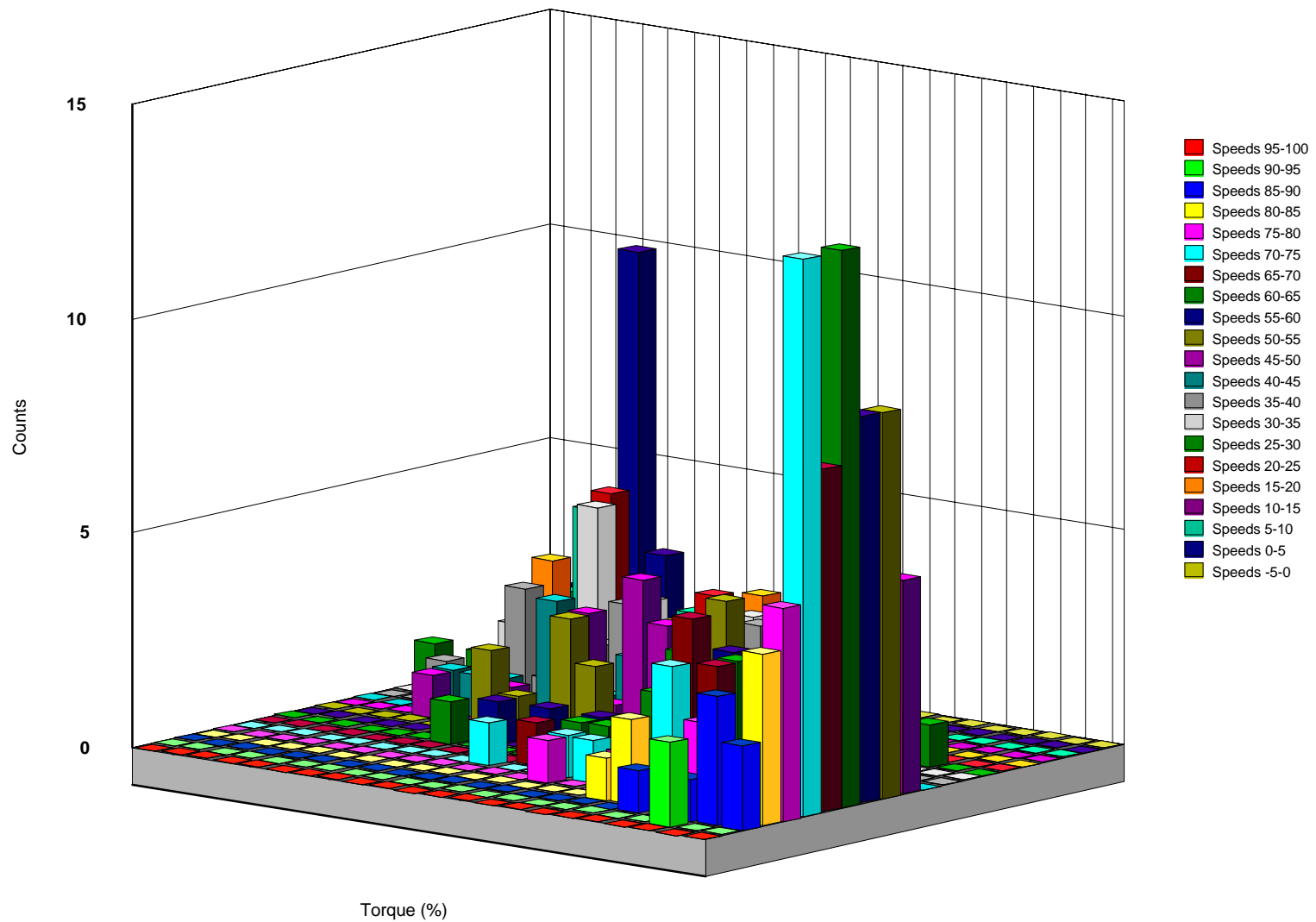
## WHEEL LOADER TYPICAL 1--Speed Steady State Means



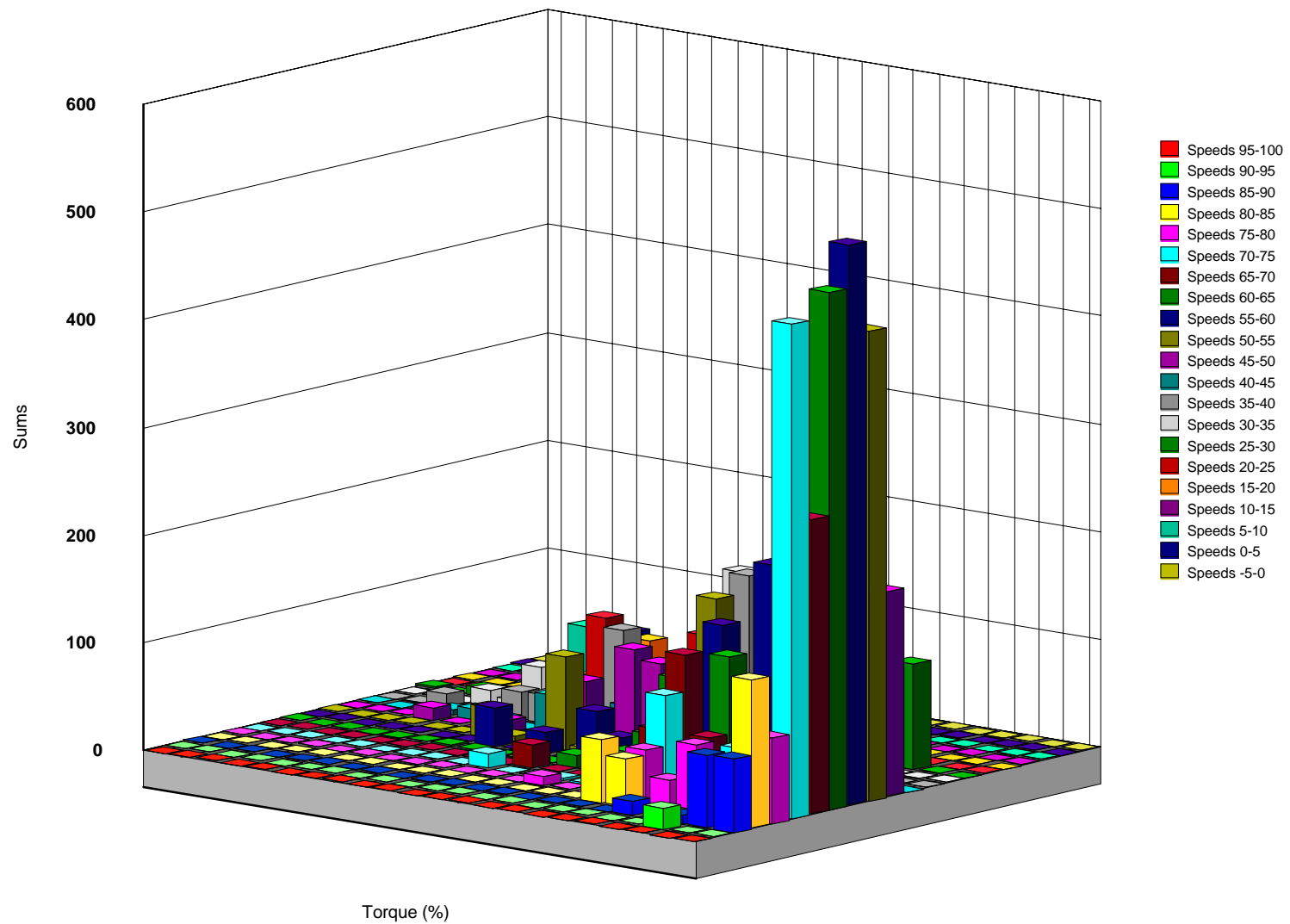
**WHEEL LOADER TYPICAL 1--Speed Steady State Standard Deviations**



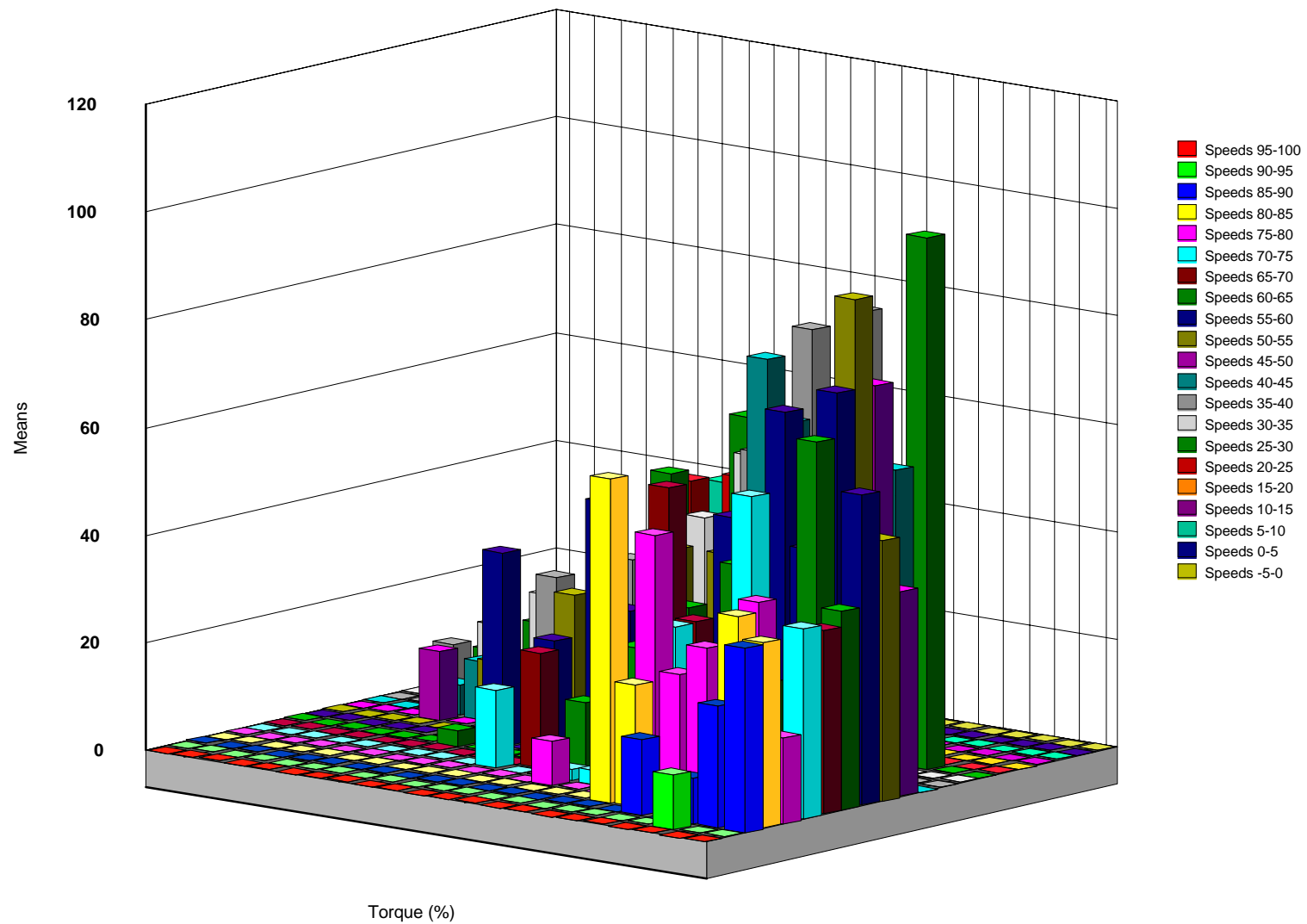
## WHEEL LOADER TYPICAL 1--Torque Acceleration Counts



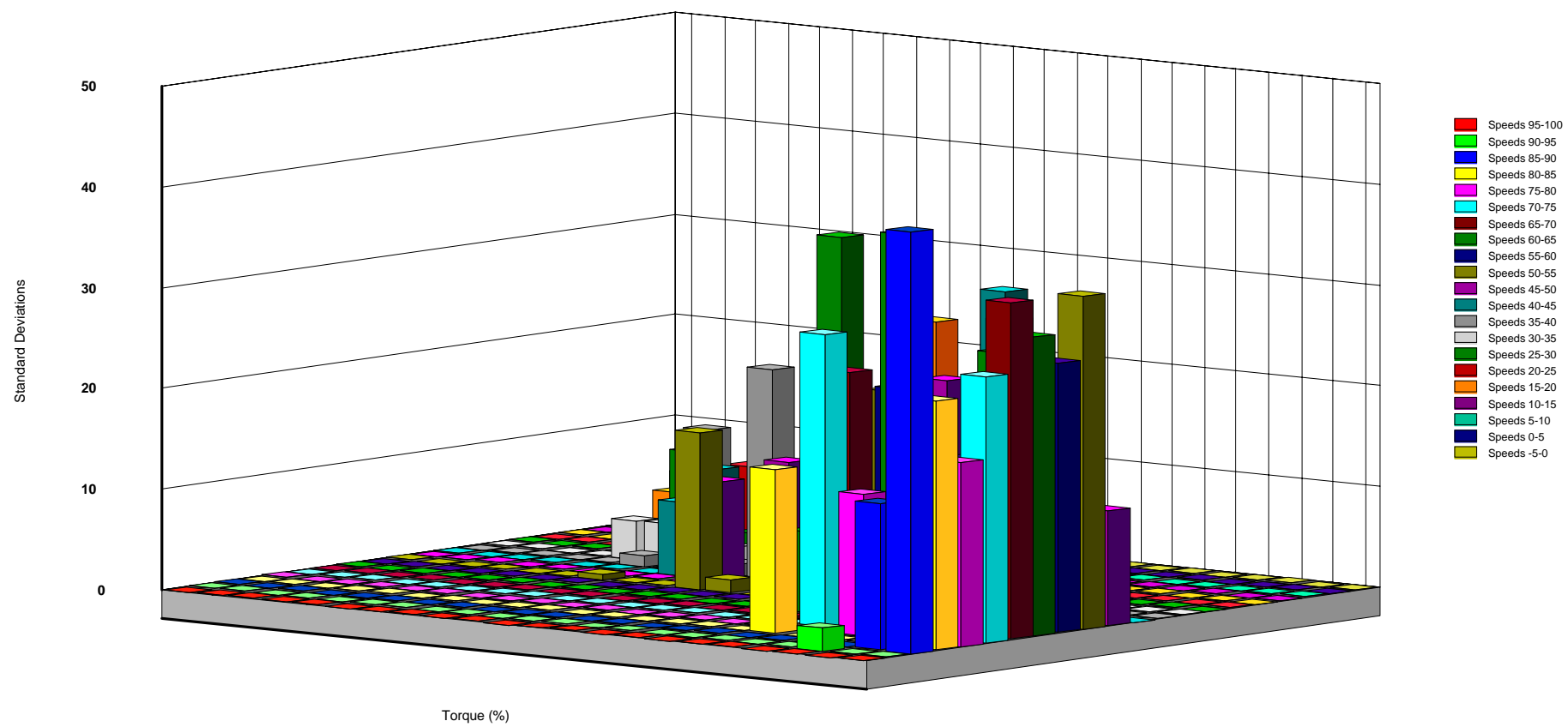
## WHEEL LOADER TYPICAL 1--Torque Acceleration Sums



## WHEEL LOADER TYPICAL 1--Torque Acceleration Means

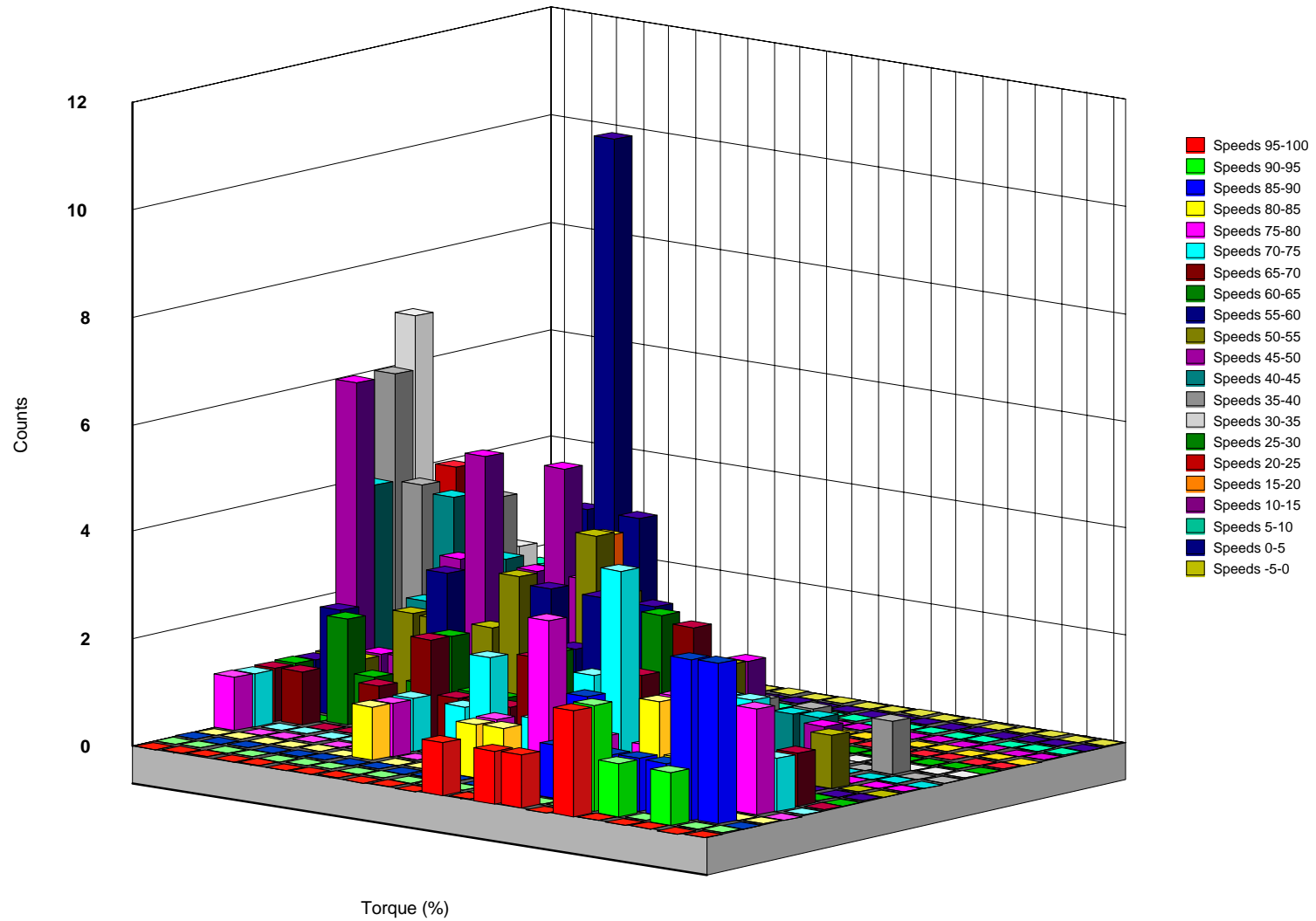


### WHEEL LOADER TYPICAL 1--Torque Acceleration Standard Deviations

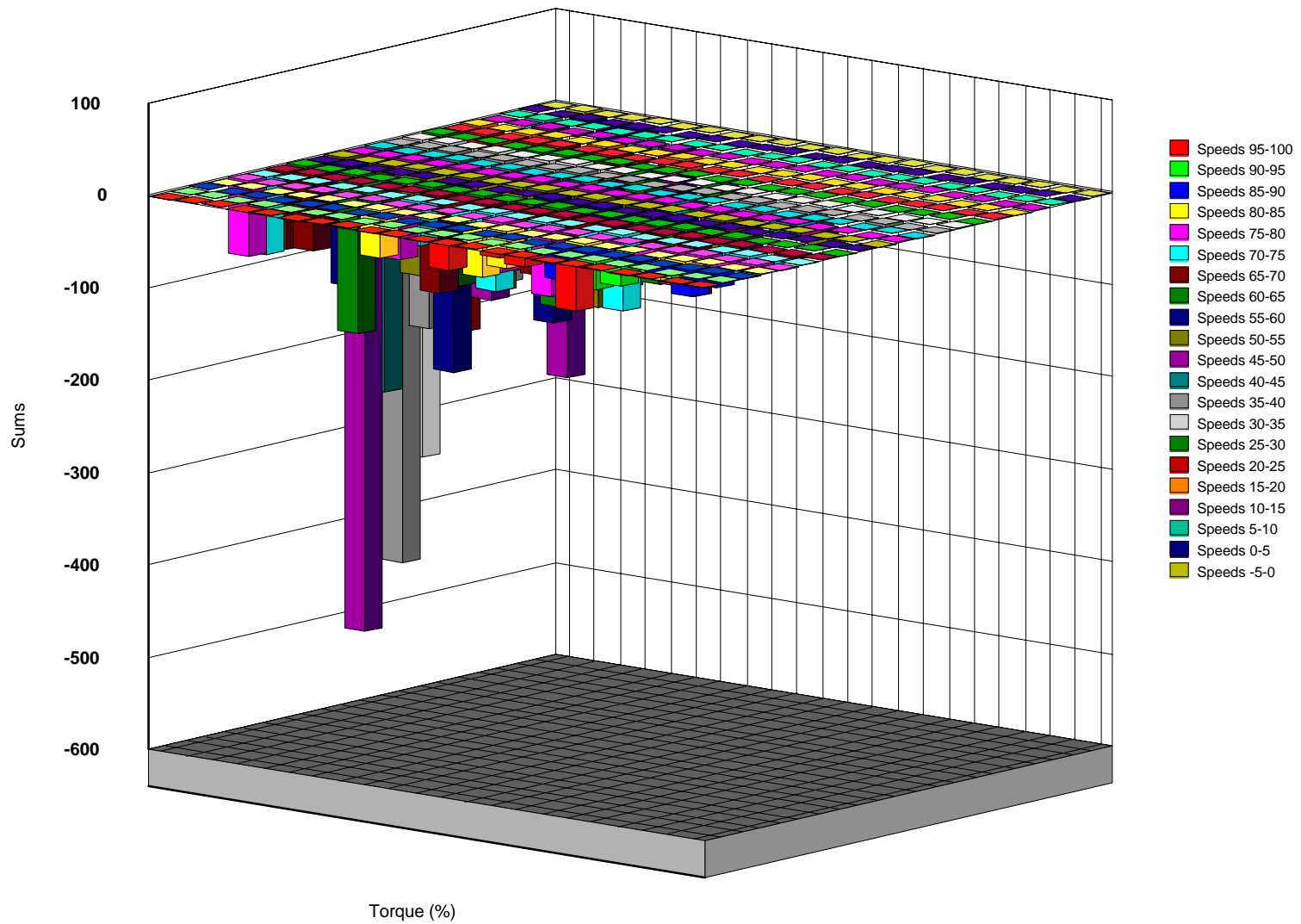




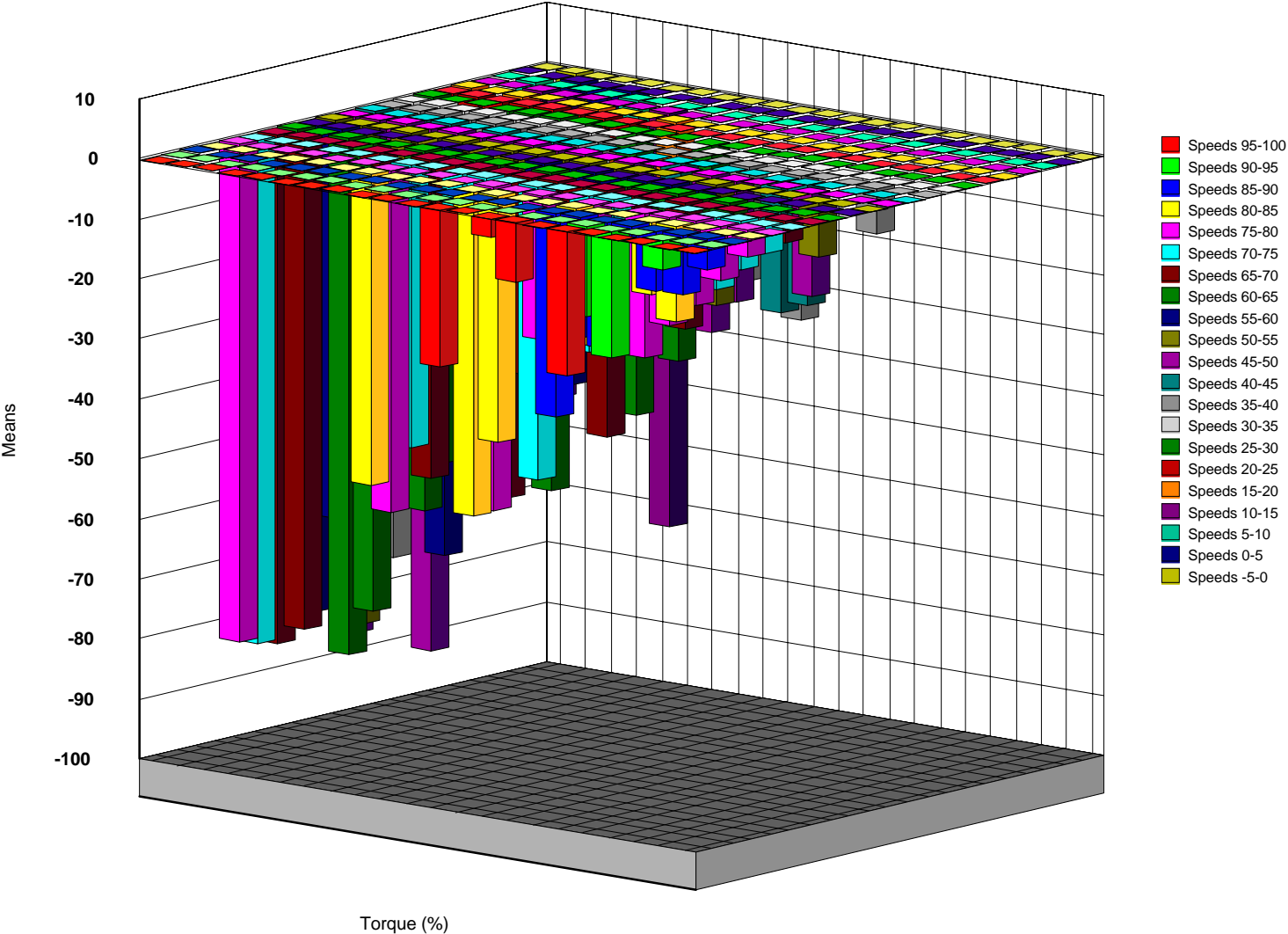
## WHEEL LOADER TYPICAL 1--Torque Deceleration Counts



## WHEEL LOADER TYPICAL 1--Torque Deceleration Sums

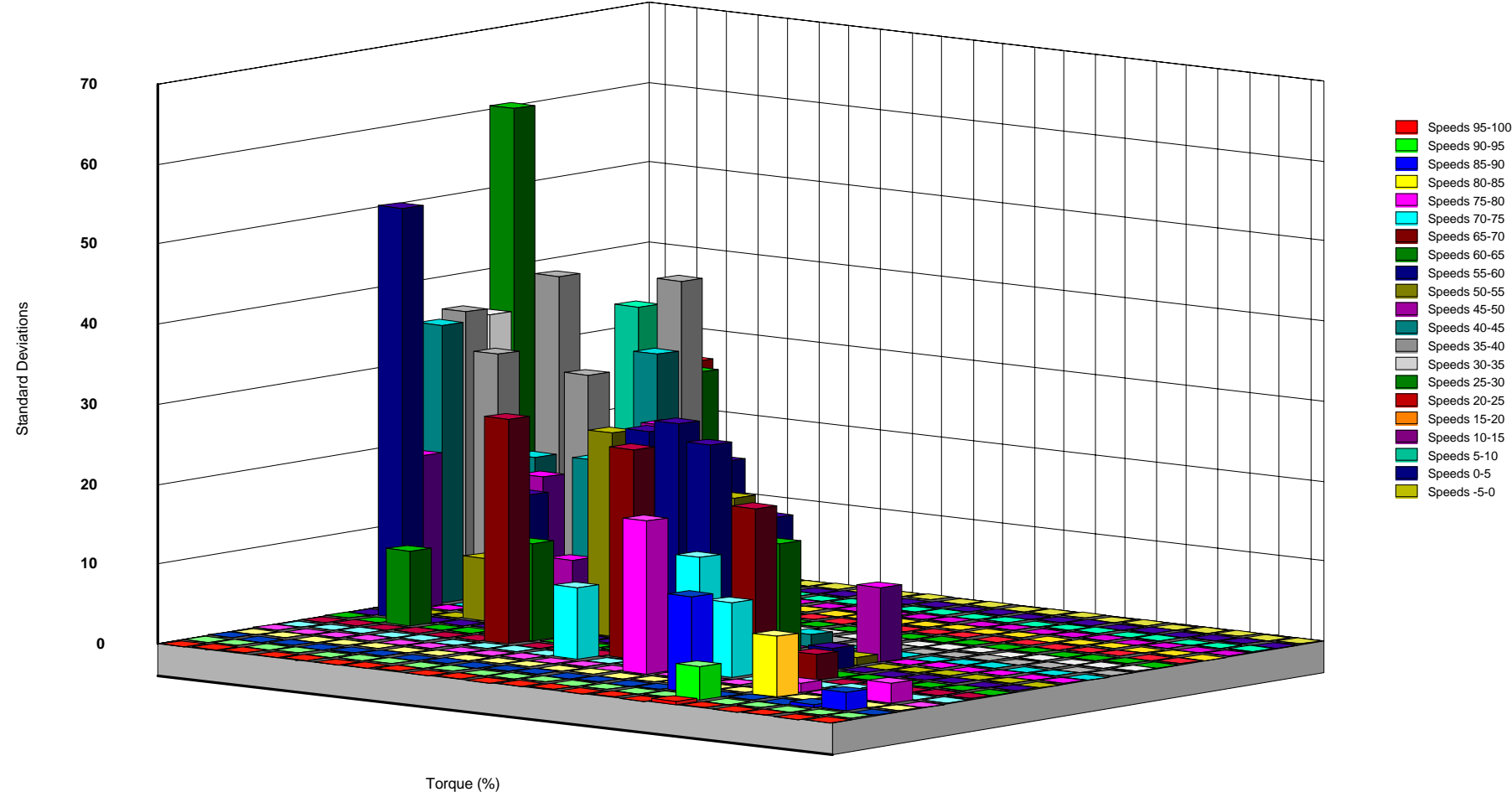


# WHEEL LOADER TYPICAL 1--Torque Deceleration Means

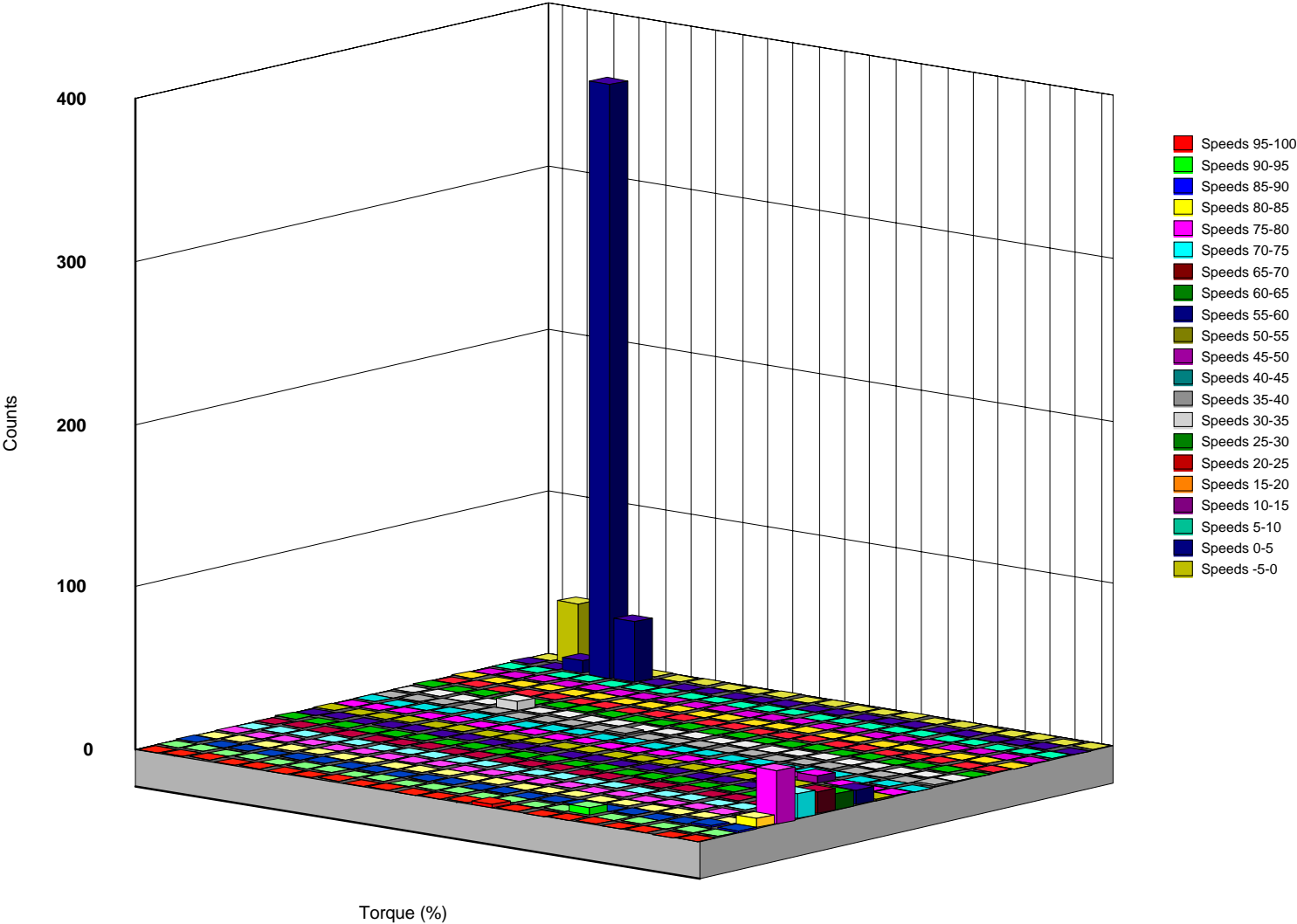




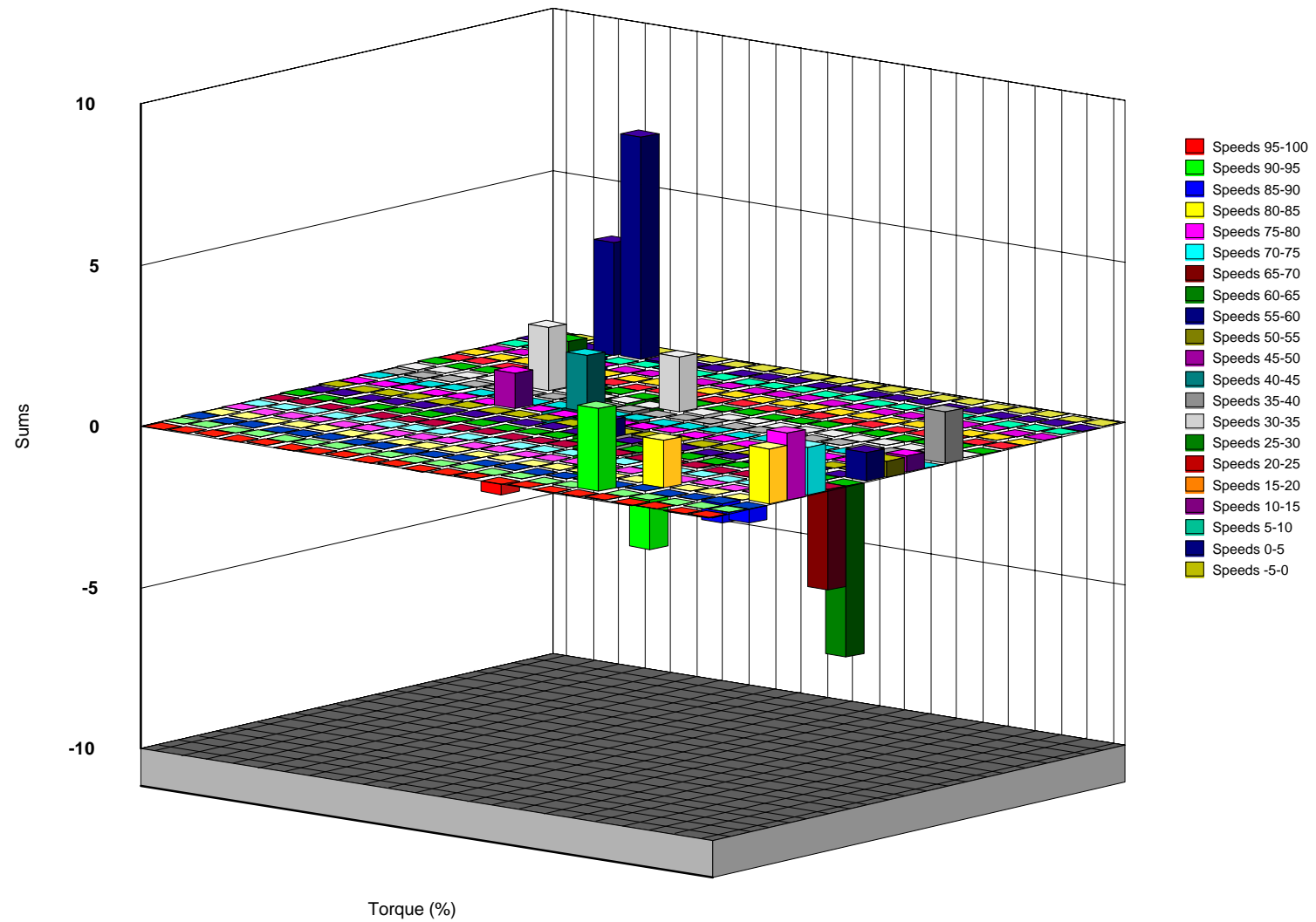
WHEEL LOADER TYPICAL 1--Torque Deceleration Standard Deviations



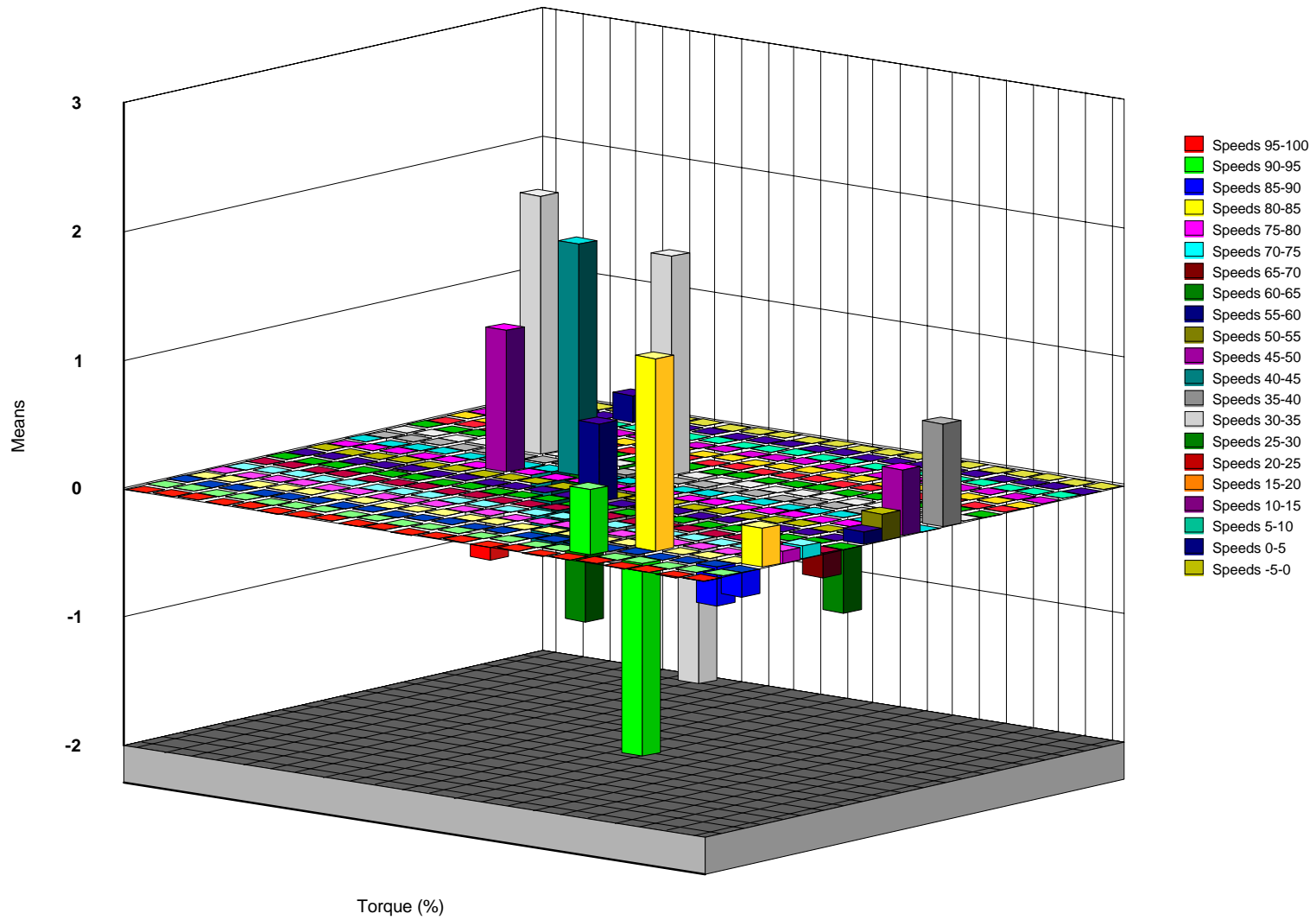
WHEEL LOADER TYPICAL 1--Torque Steady State Counts



## WHEEL LOADER TYPICAL 1--Torque Steady State Sums

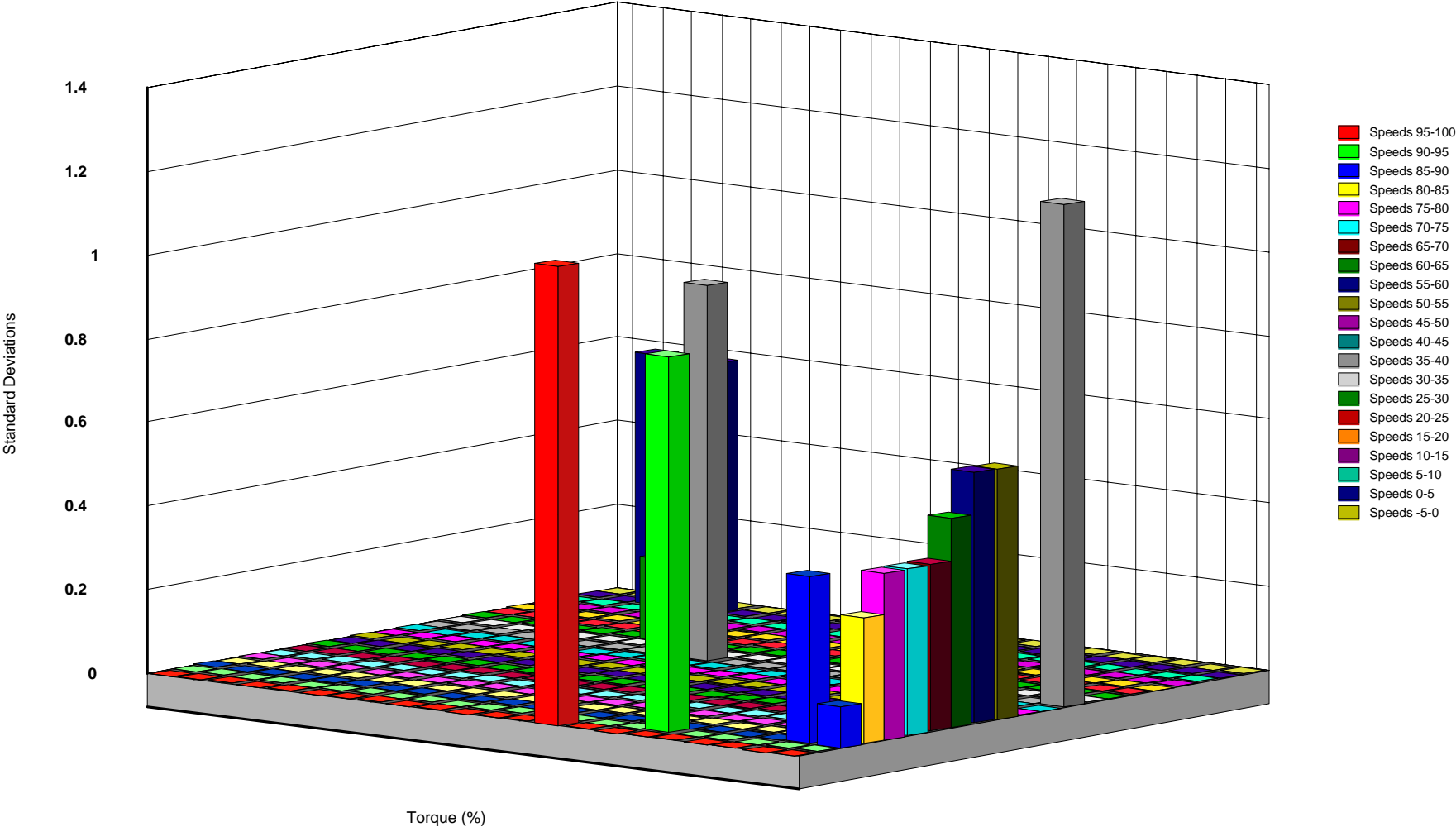


## WHEEL LOADER TYPICAL 1--Torque Steady State Means

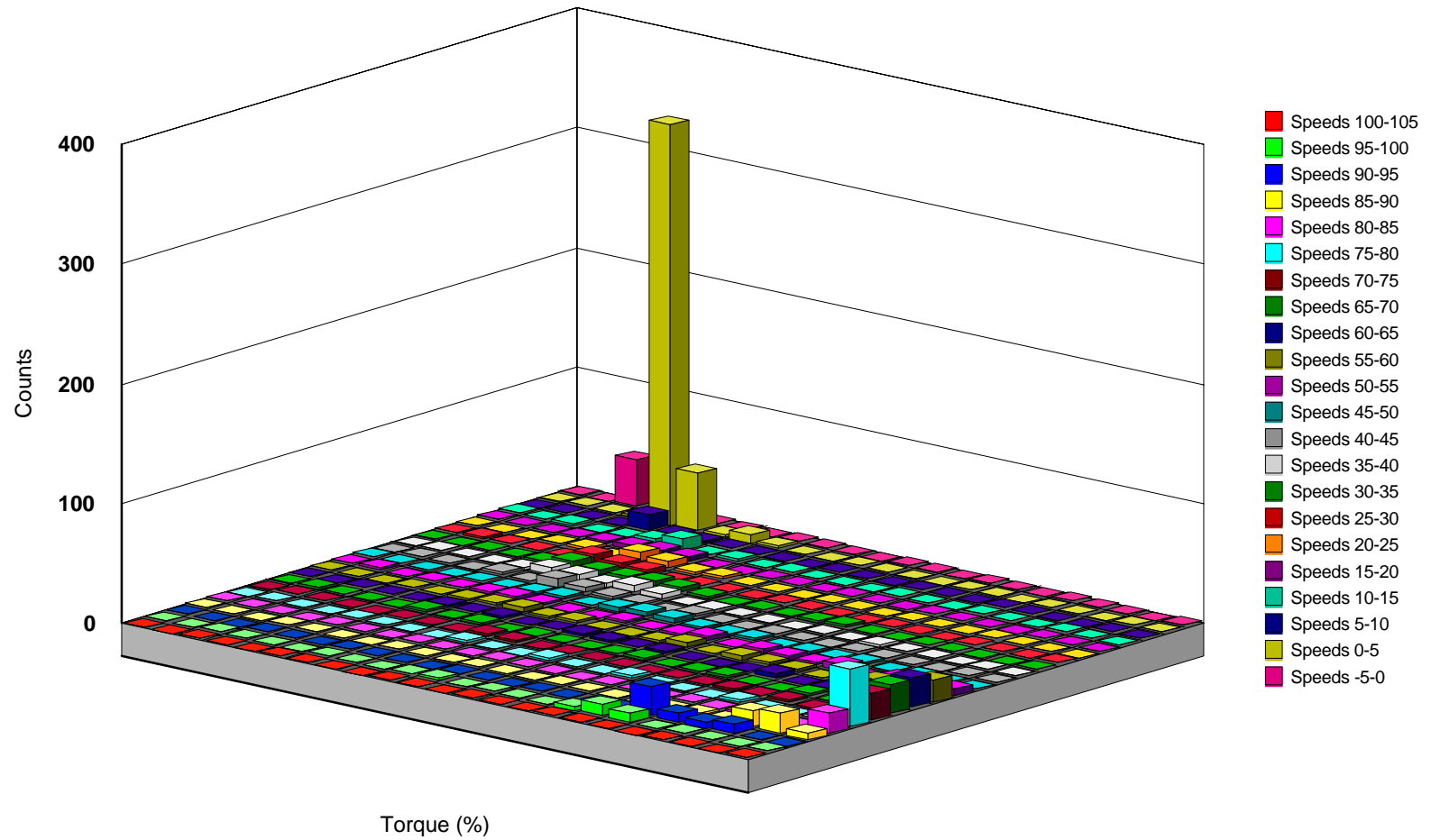




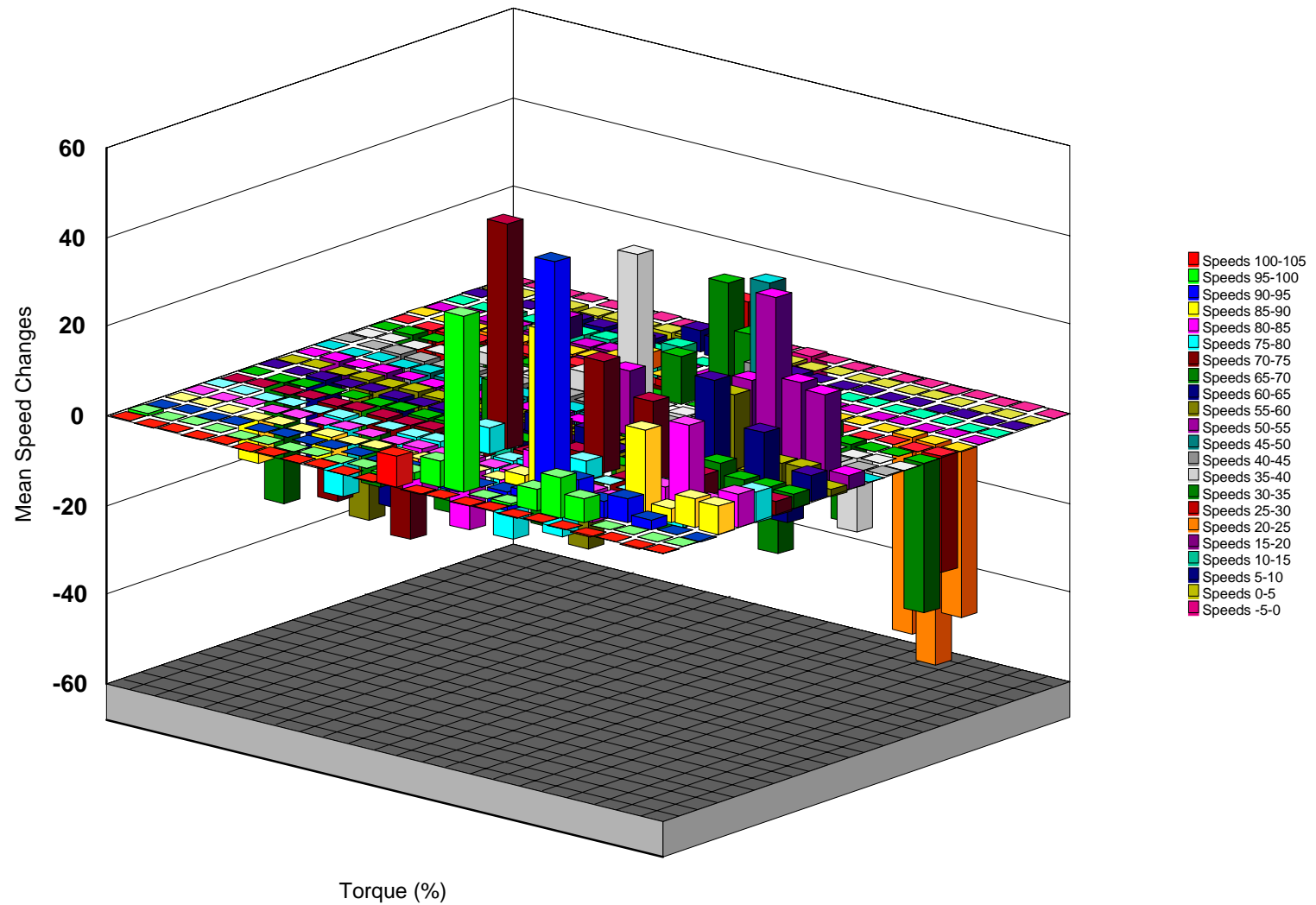
WHEEL LOADER TYPICAL 1--Torque Steady State Standard Deviations



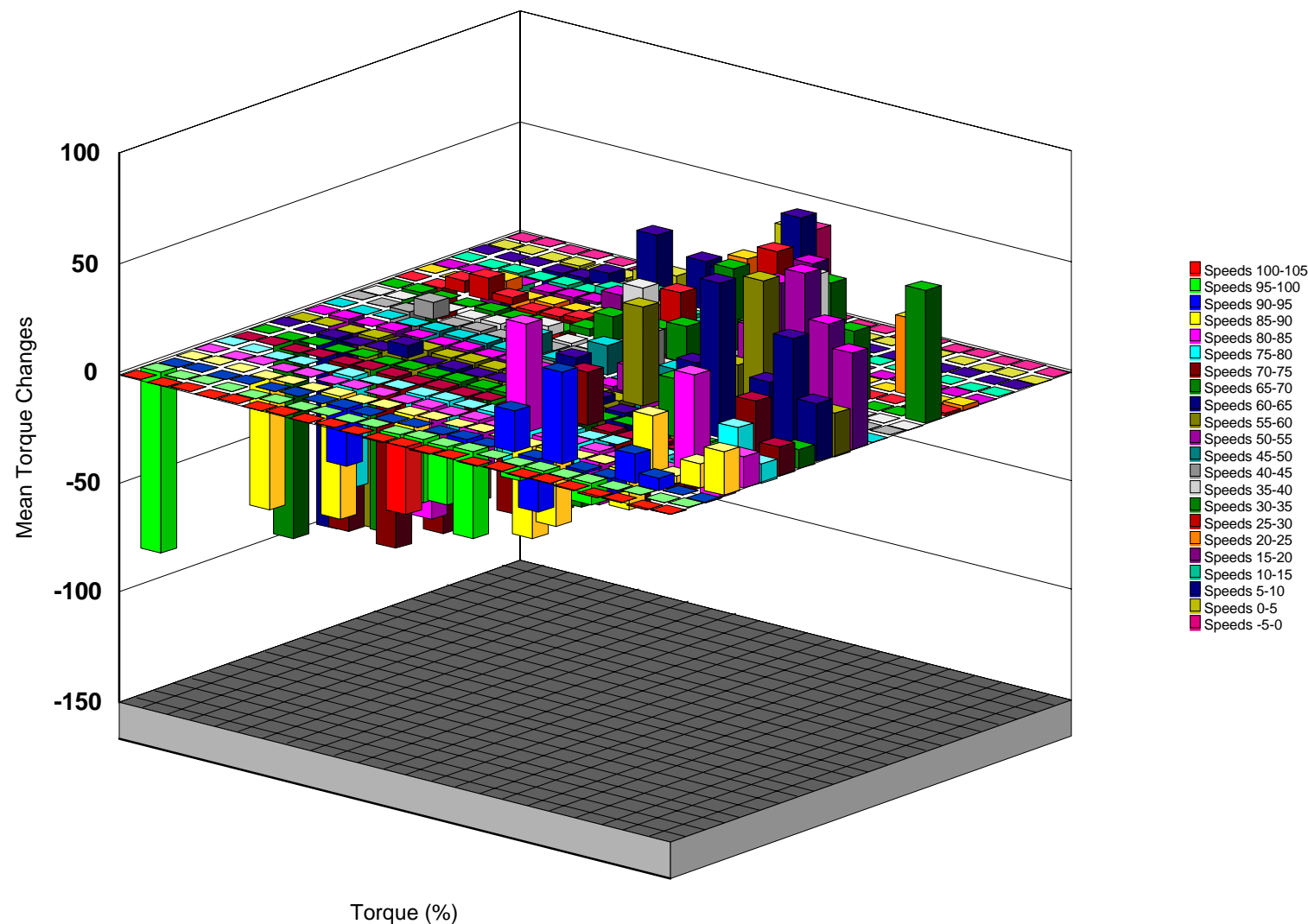
## WHEEL LOADER TYPICAL 2--Counts



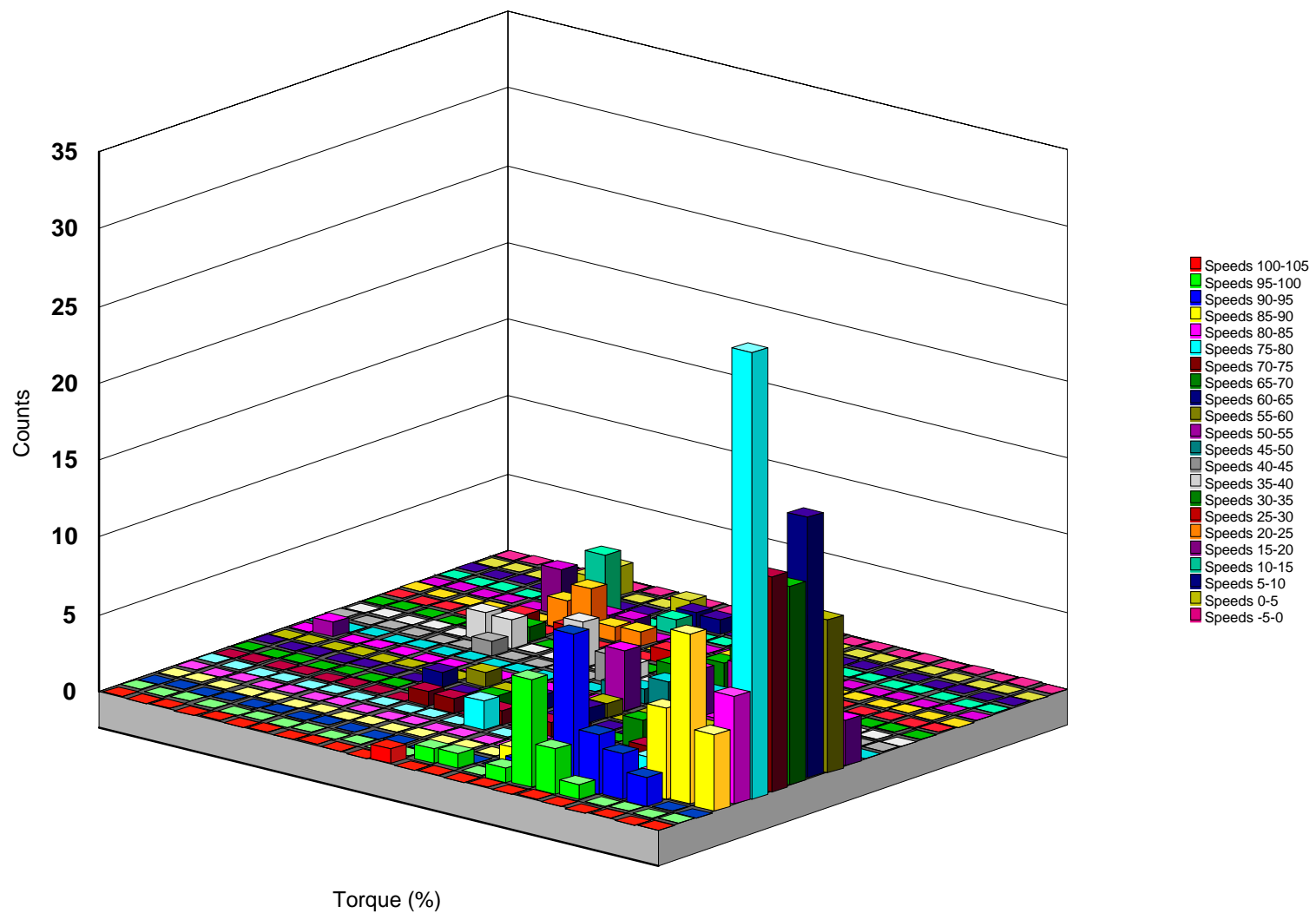
## WHEEL LOADER TYPICAL 2--Mean Speed Changes



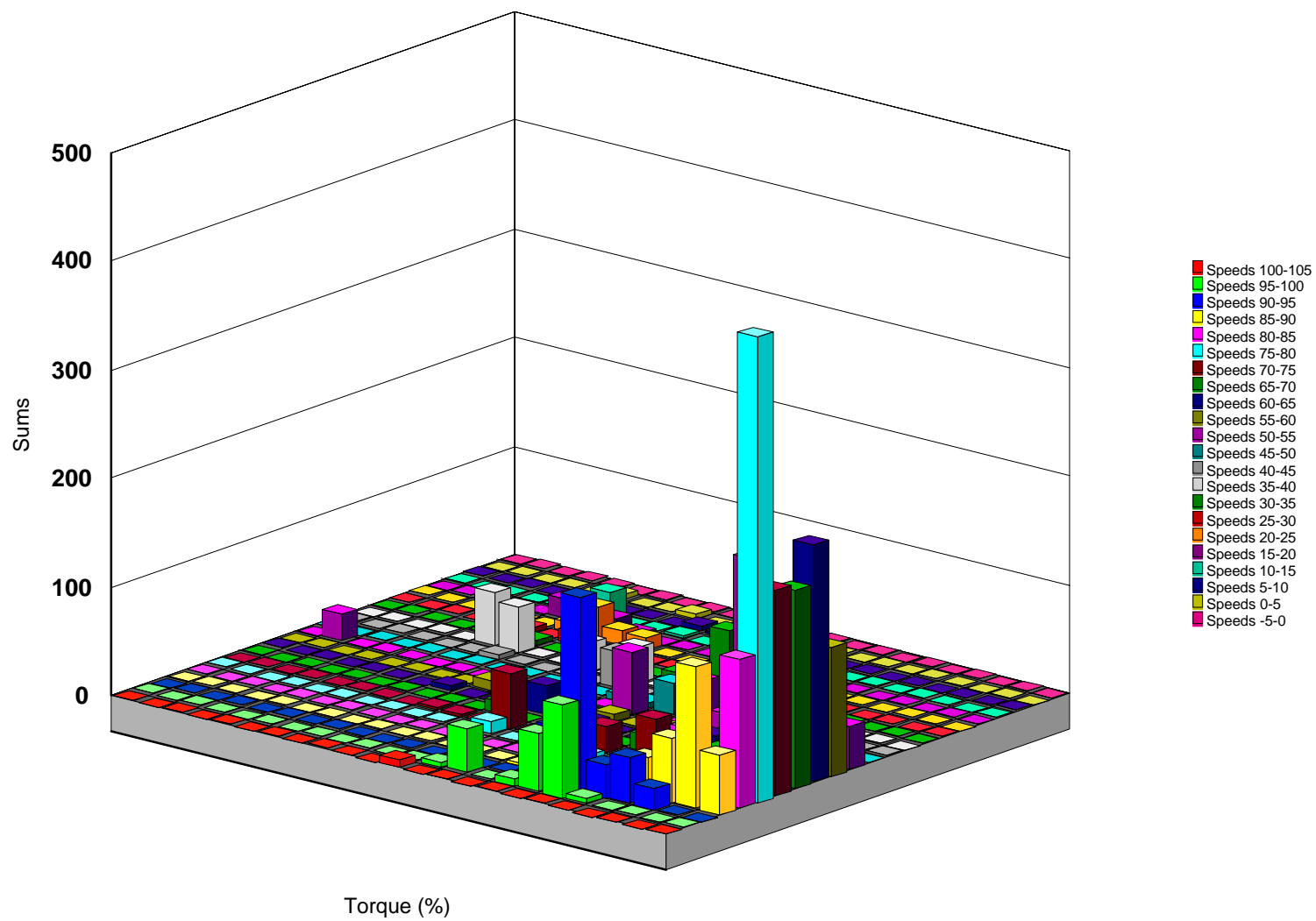
# WHEEL LOADER TYPICAL 2--Mean Torque Changes



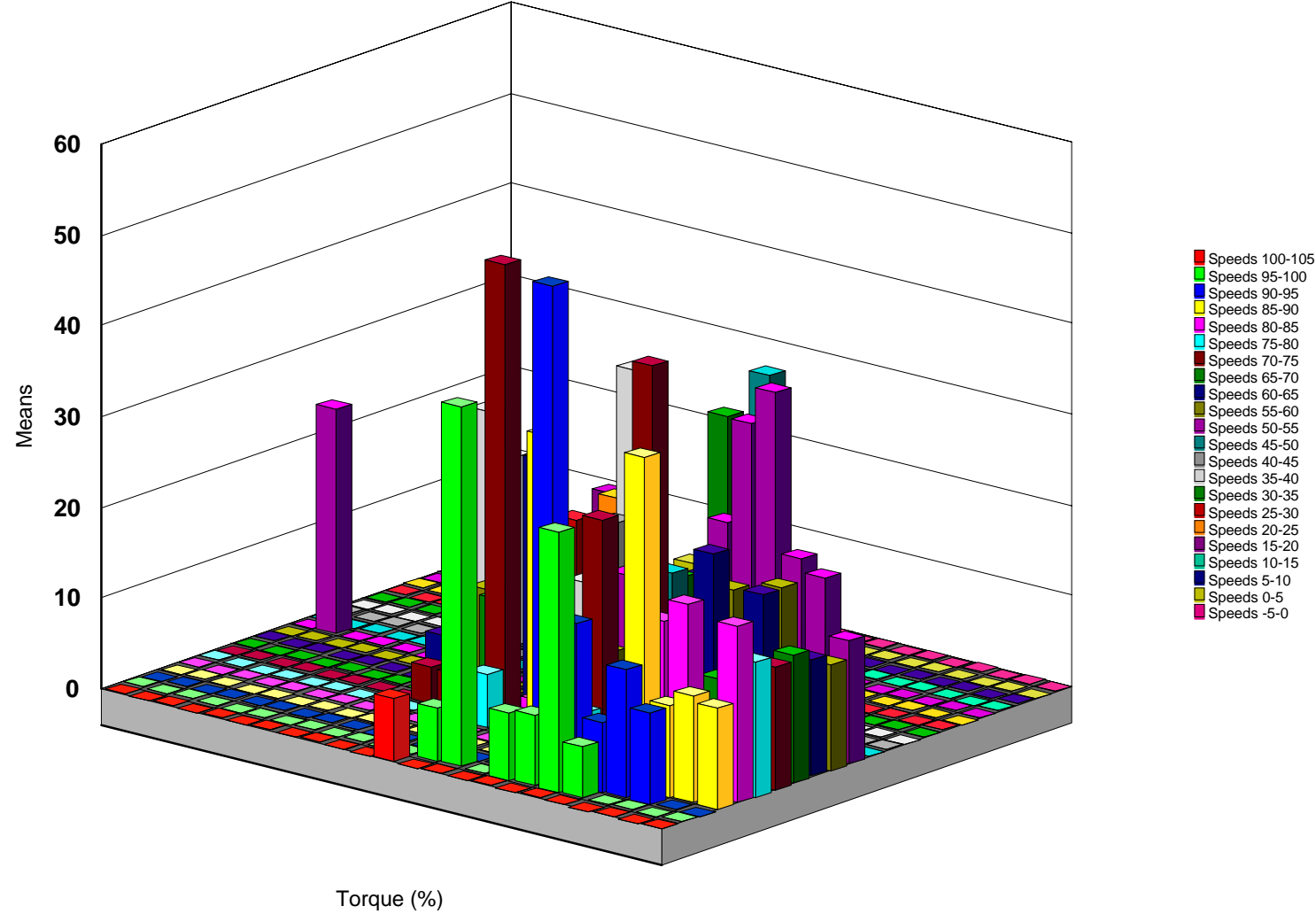
## WHEEL LOADER TYPICAL 2--Speed Acceleration Cou



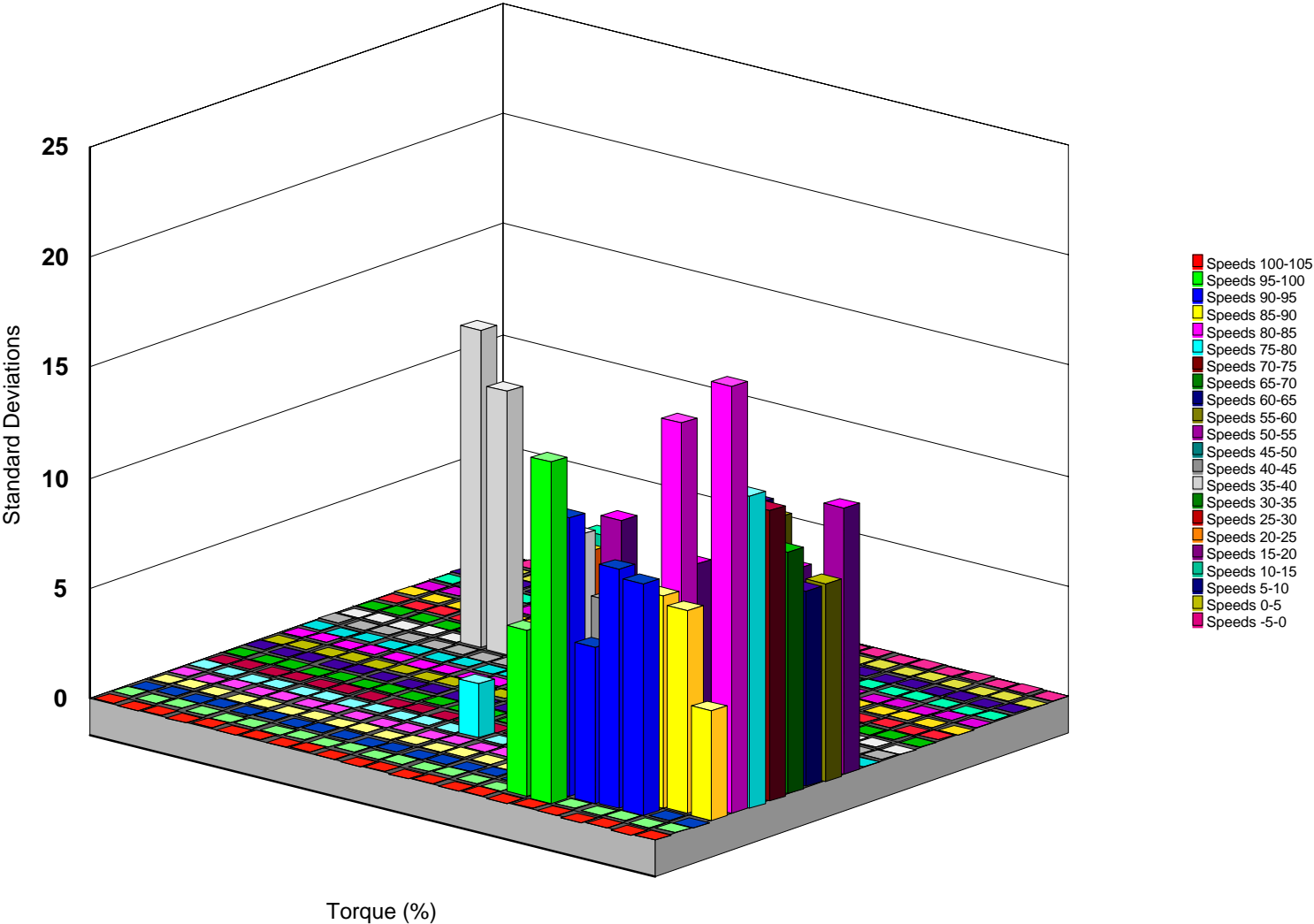
## WHEEL LOADER TYPICAL 2--Speed Acceleration Su



WHEEL LOADER TYPICAL 2--Speed Acceleration Me

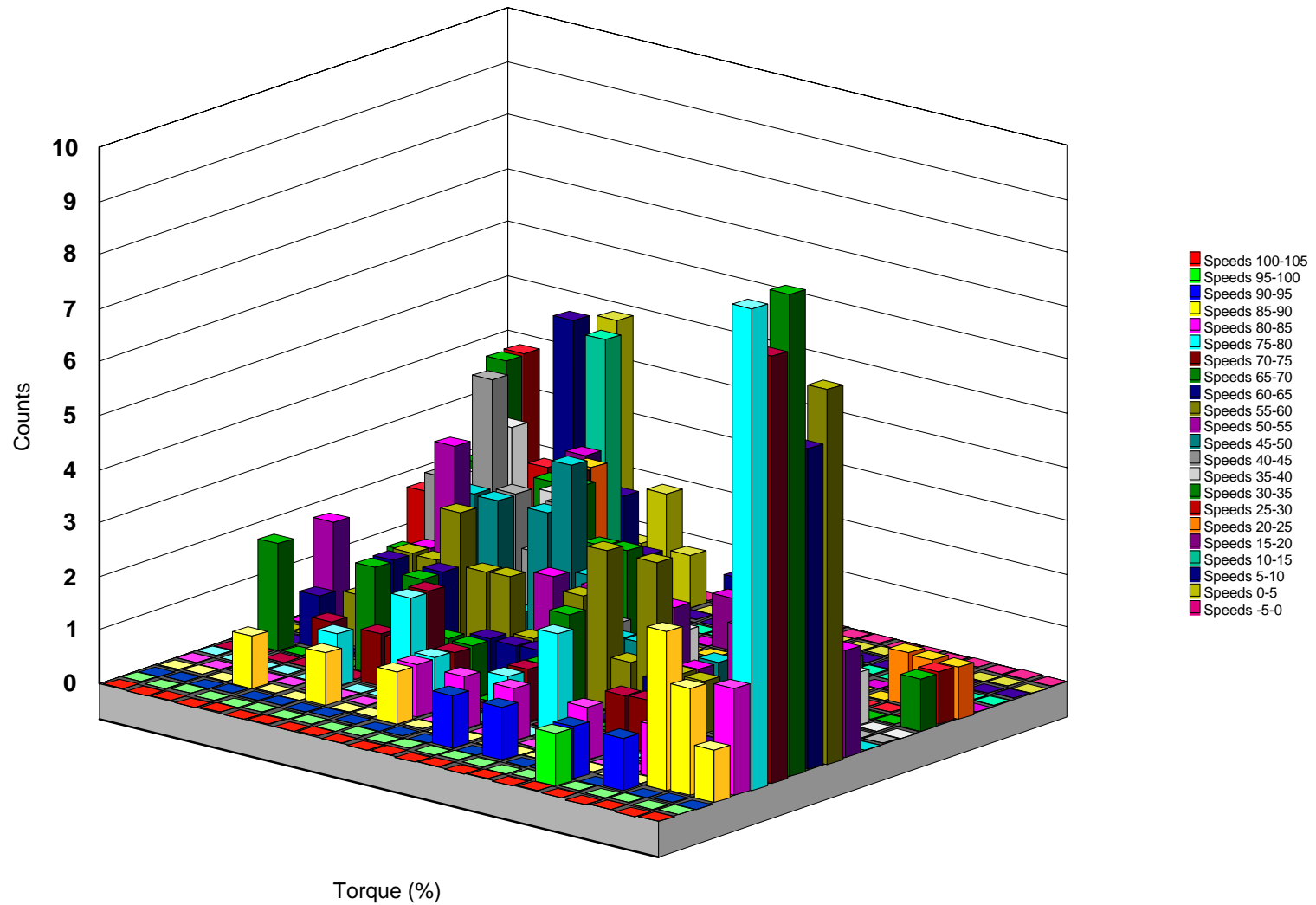


# WHEEL LOADER TYPICAL 2--Speed Acceleration Standard Dev

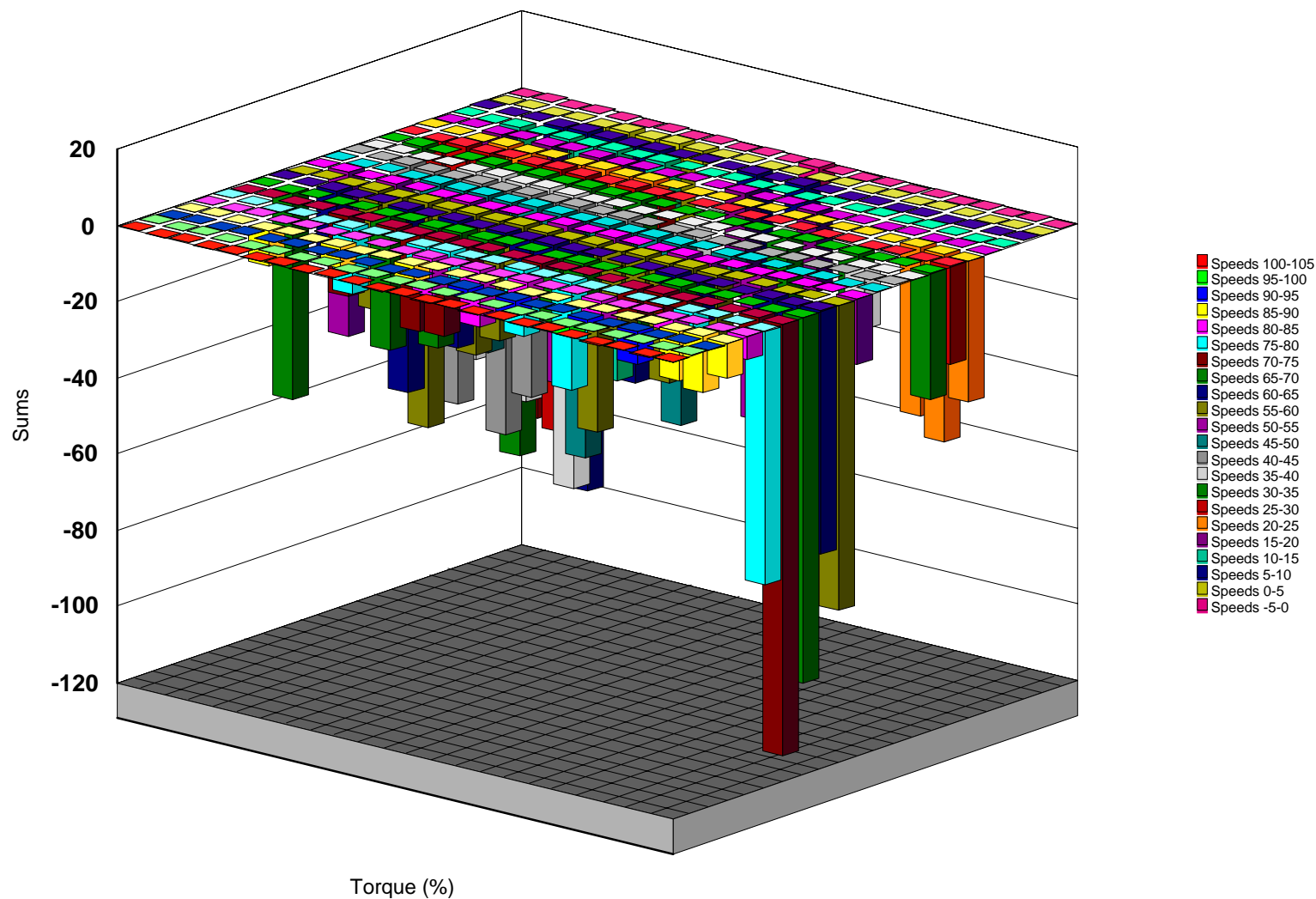




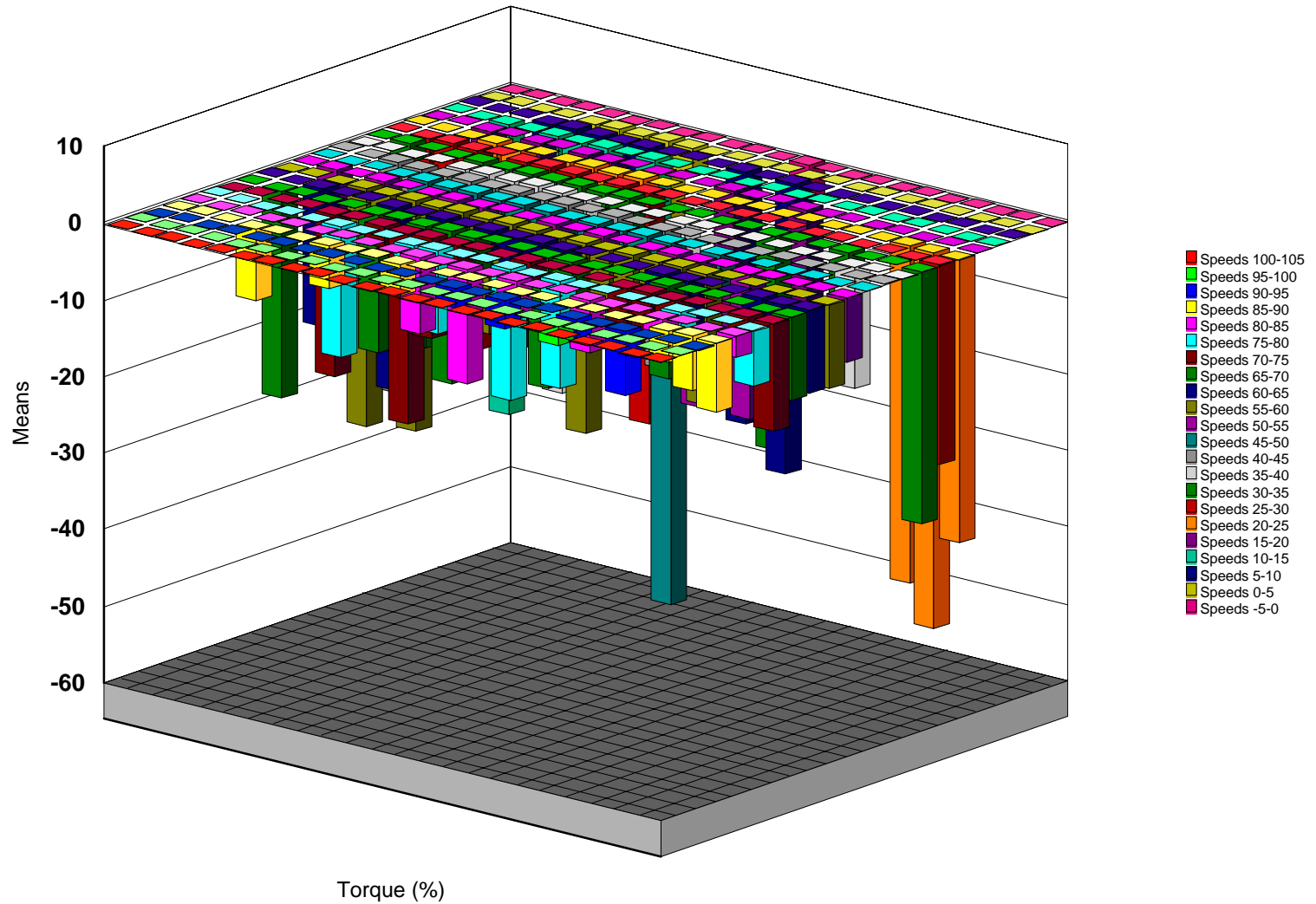
## WHEEL LOADER TYPICAL 2--Speed Deceleration Cou



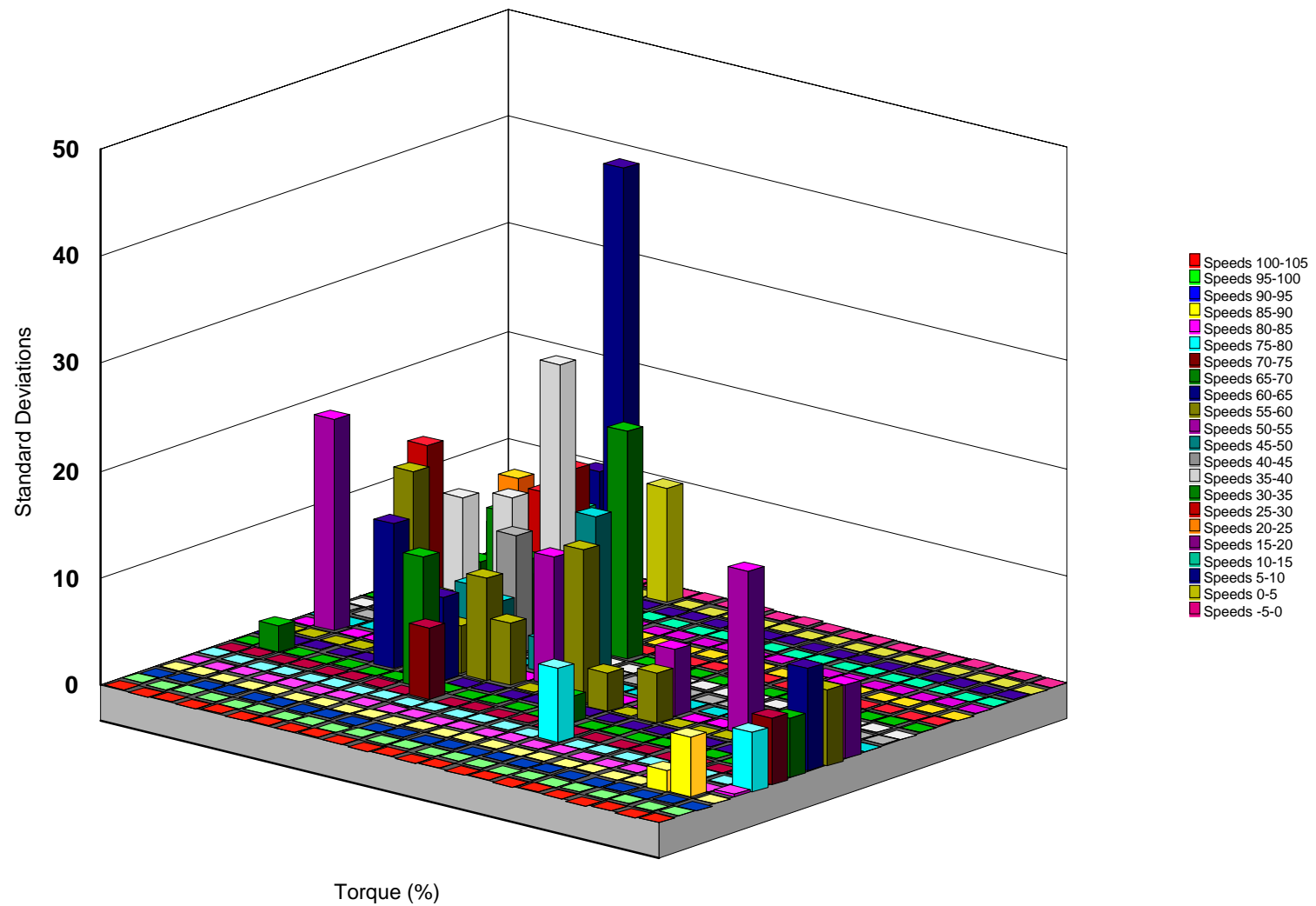
WHEEL LOADER TYPICAL 2--Speed Deceleration Sum



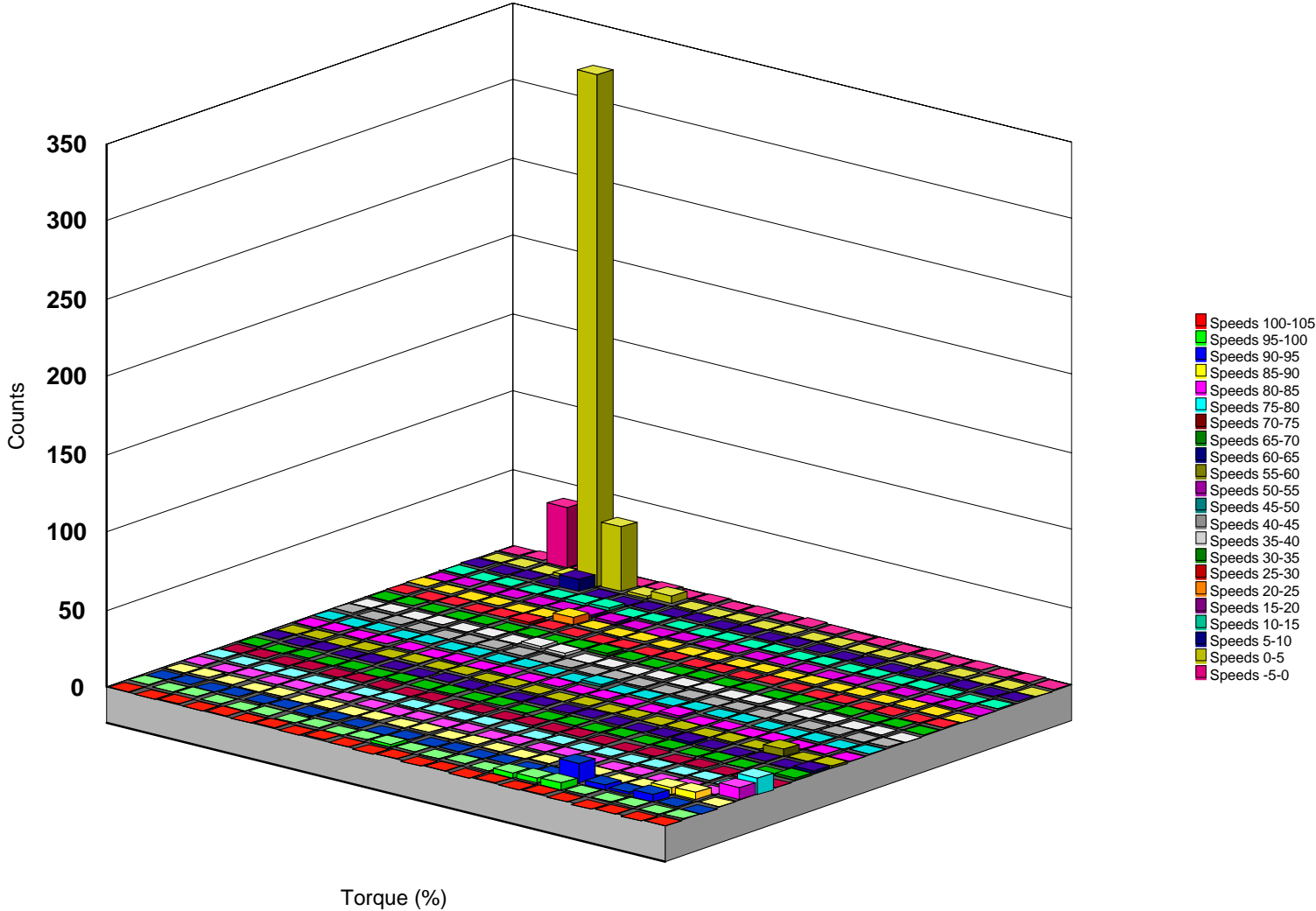
## WHEEL LOADER TYPICAL 2--Speed Deceleration



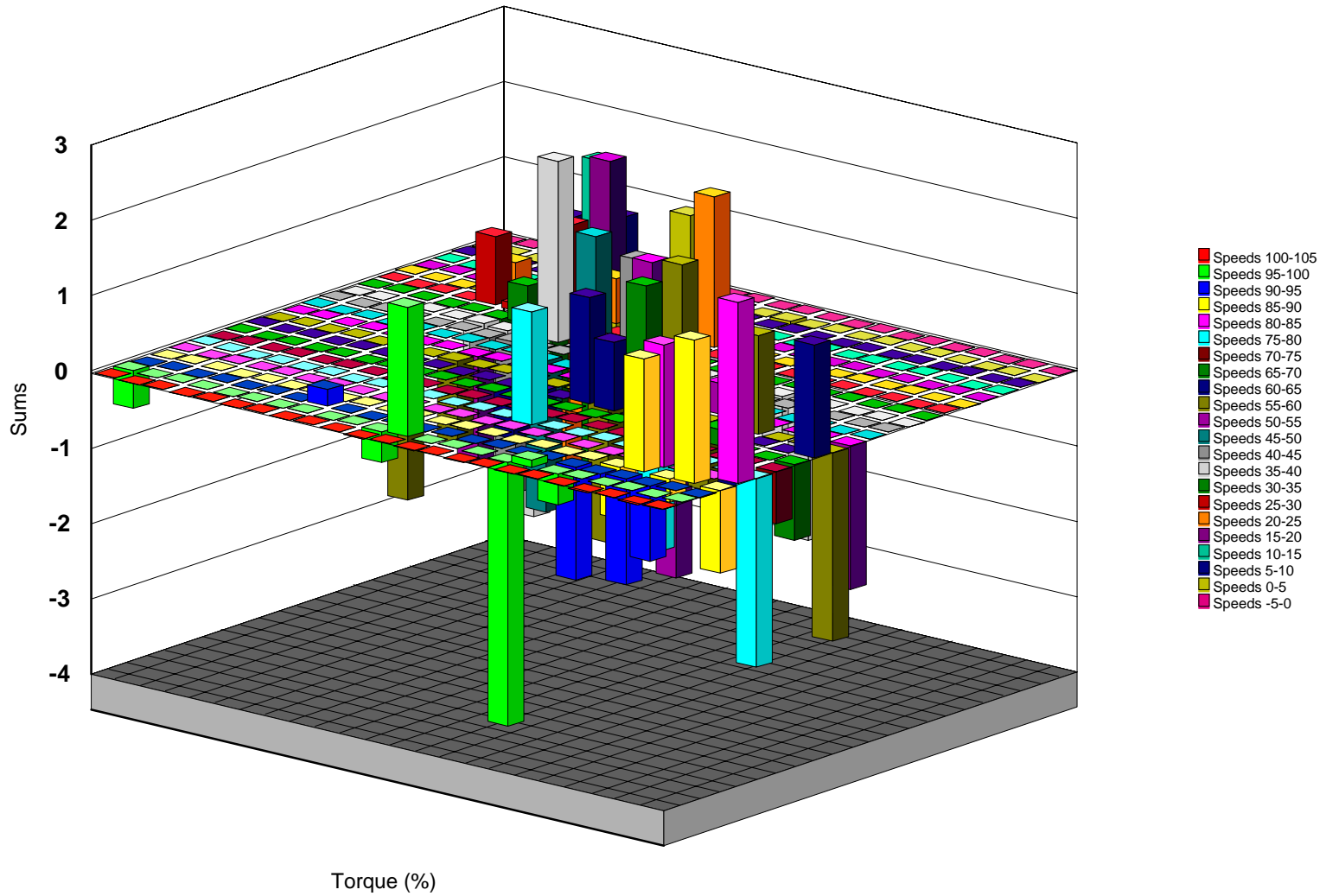
## WHEEL LOADER TYPICAL 2--Speed Deceleration Standard Devi



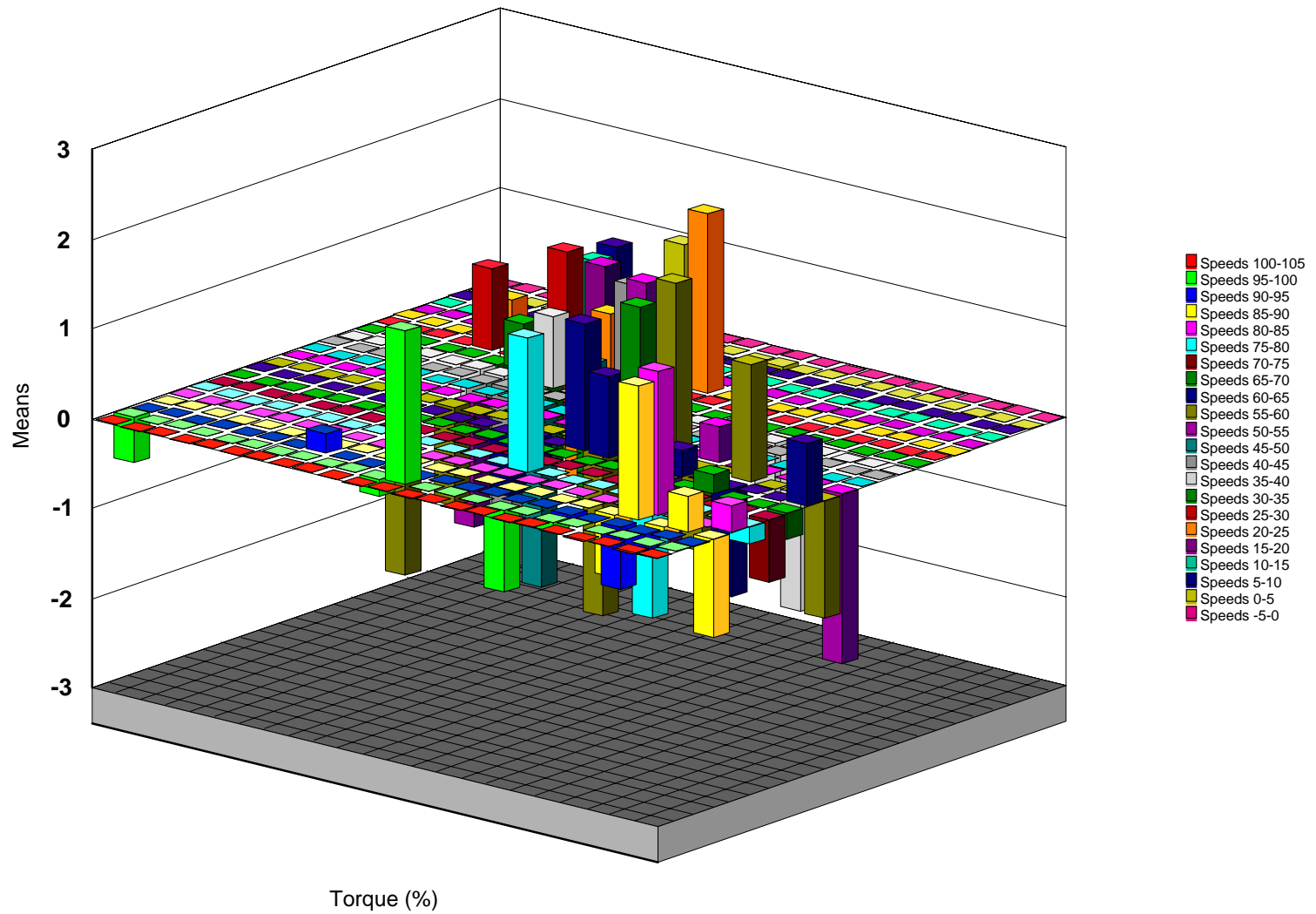
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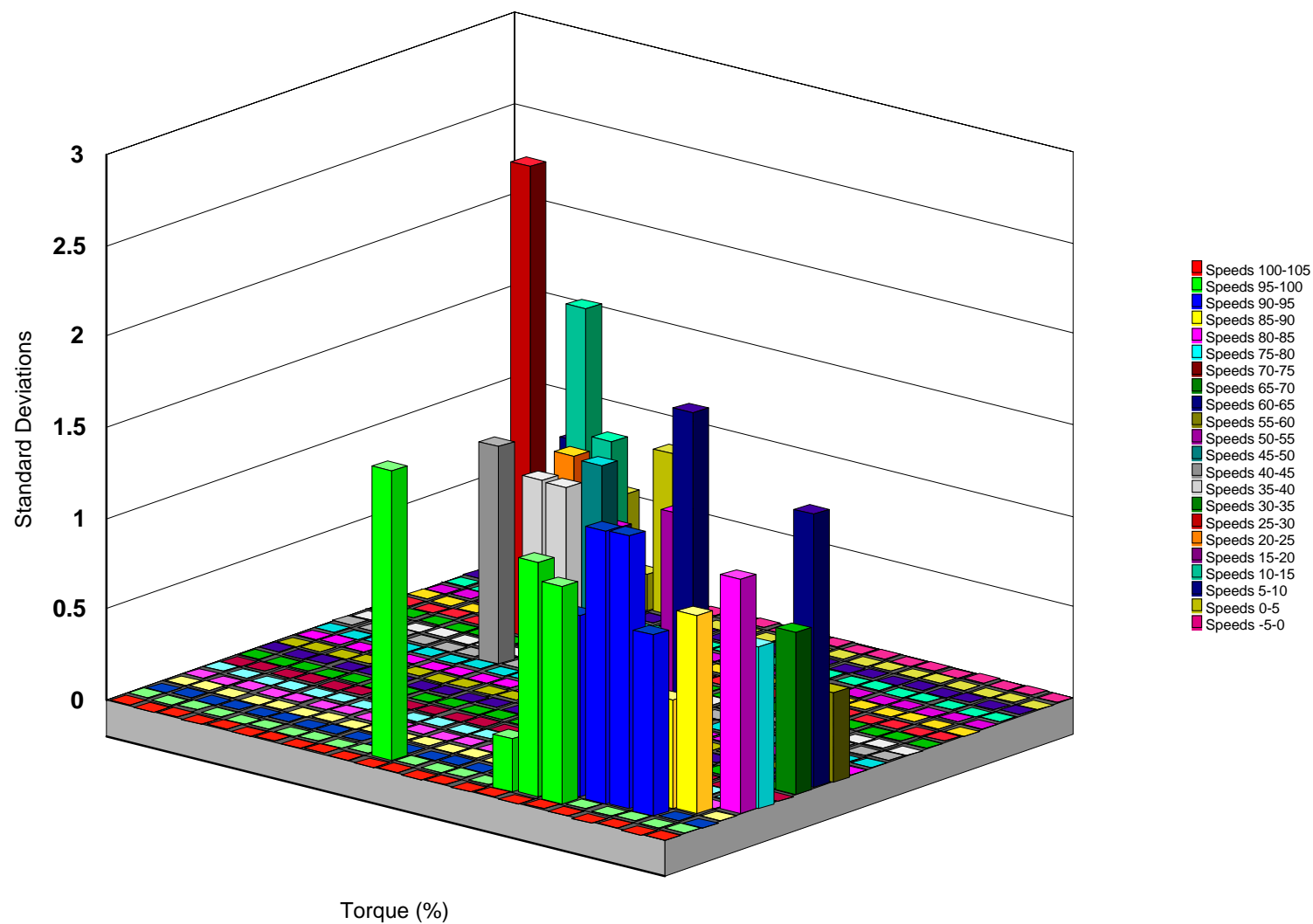
## WHEEL LOADER TYPICAL 2--Speed Steady State Sum



## WHEEL LOADER TYPICAL 2--Speed Steady State Me

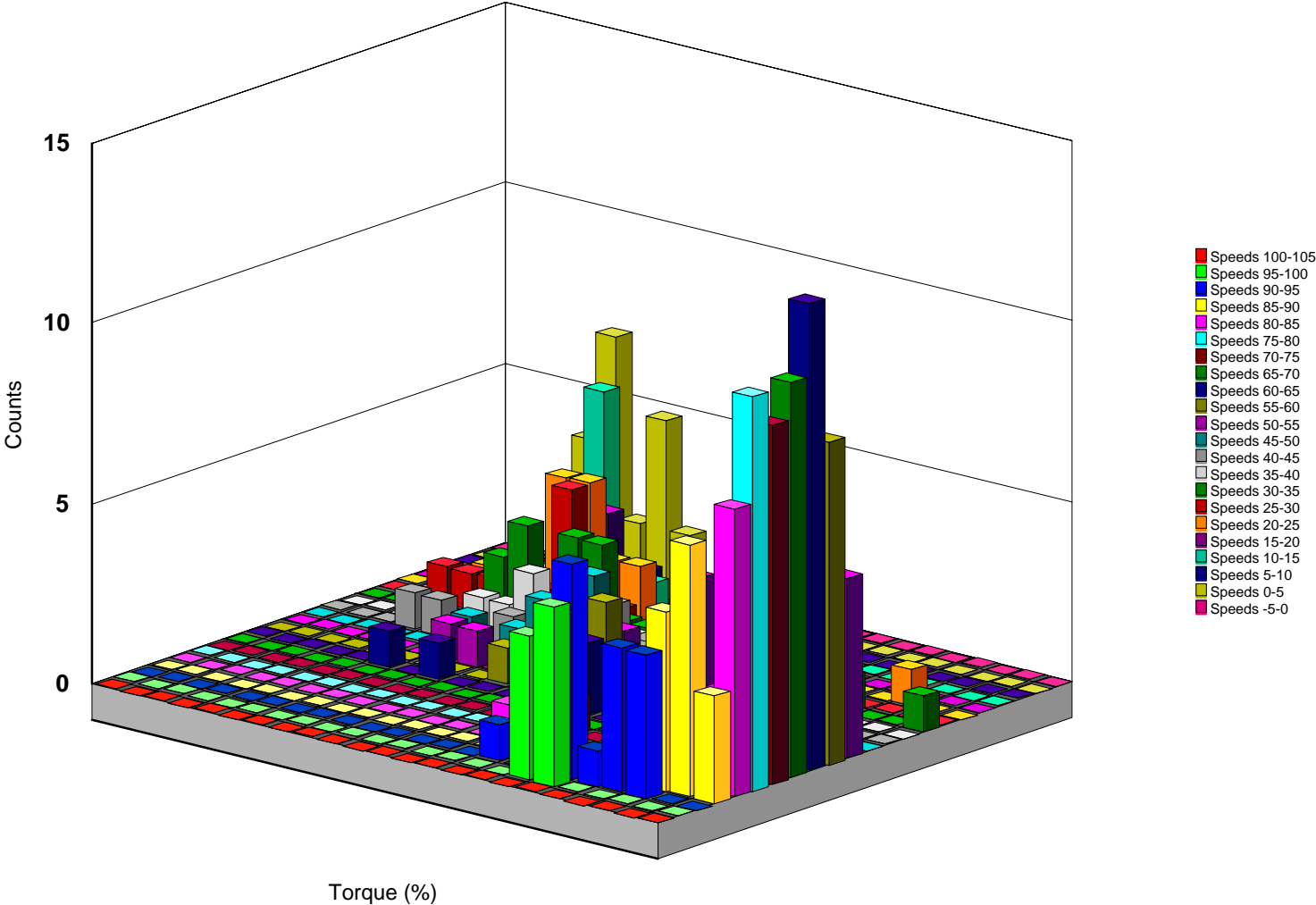


## WHEEL LOADER TYPICAL 2--Speed Steady State Standard Dev

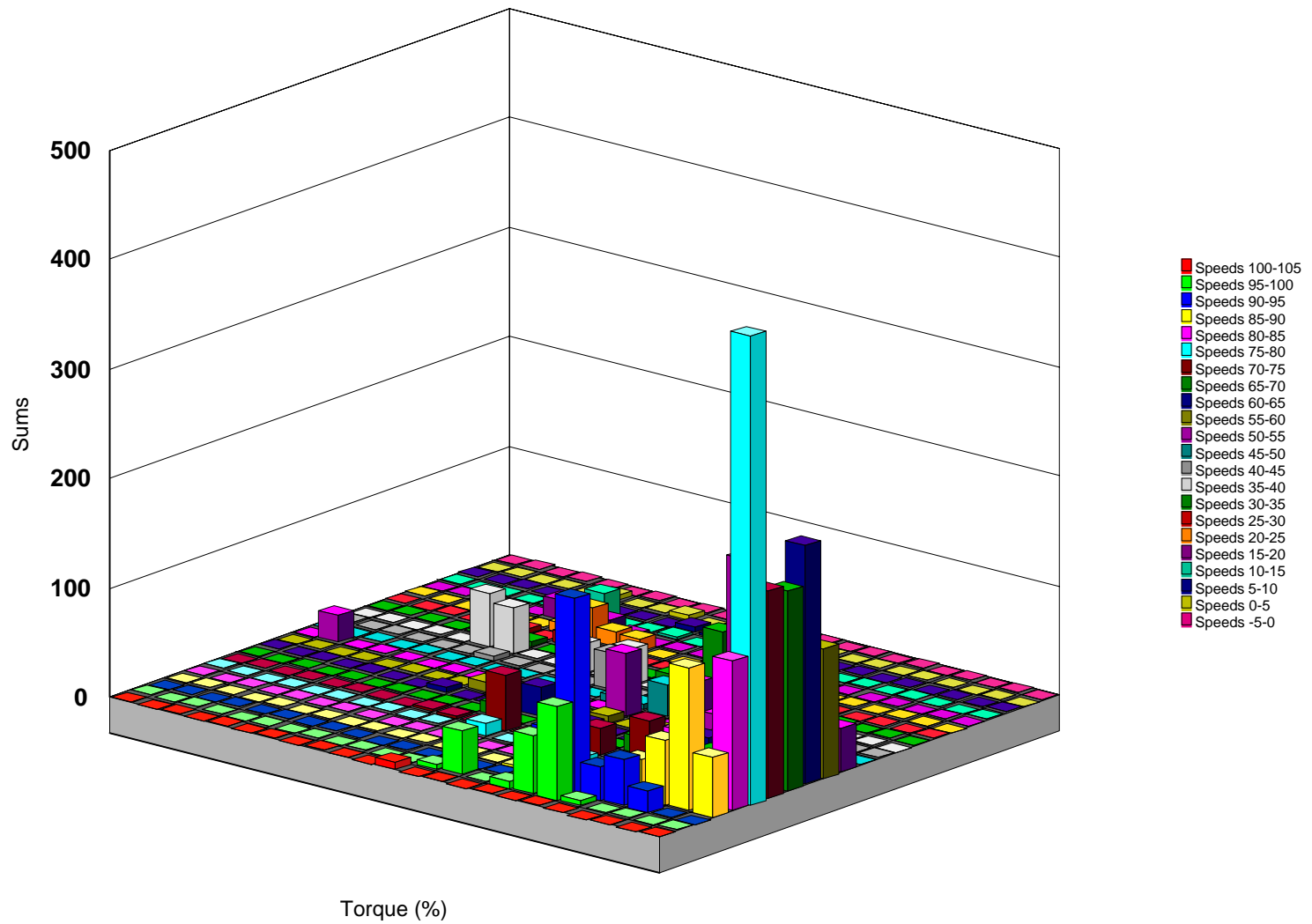




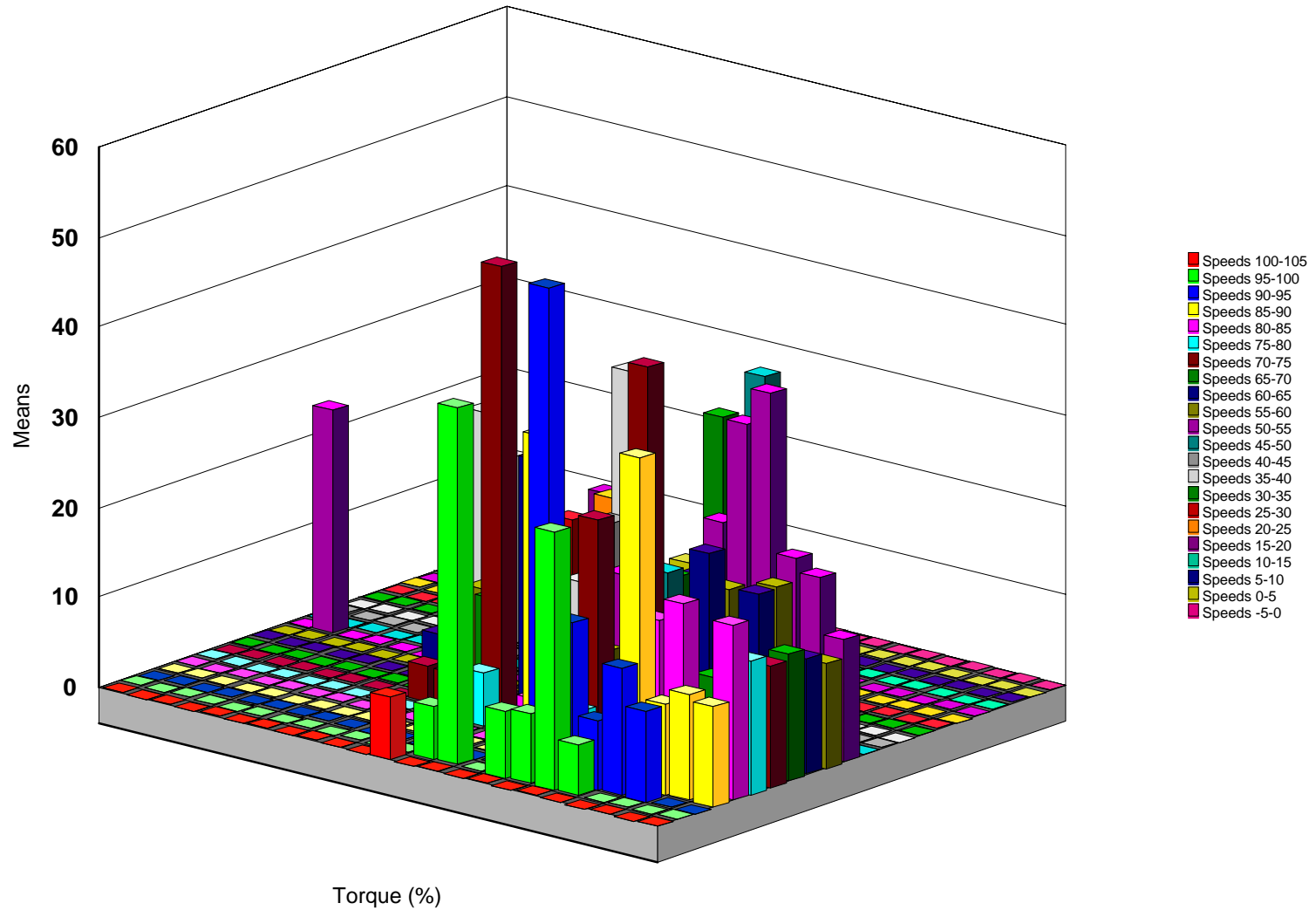
# WHEEL LOADER TYPICAL 2--Torque Acceleration Coui



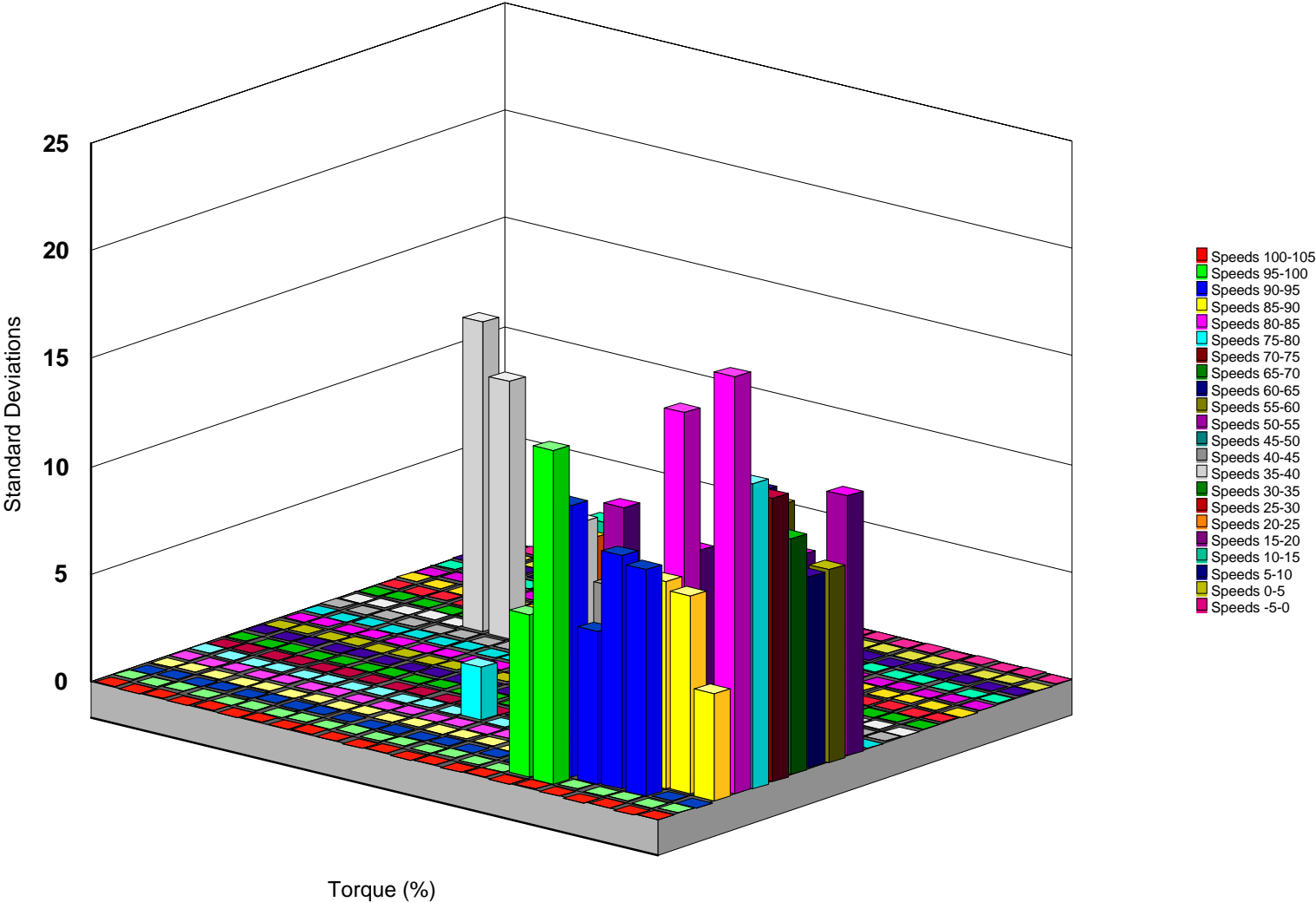
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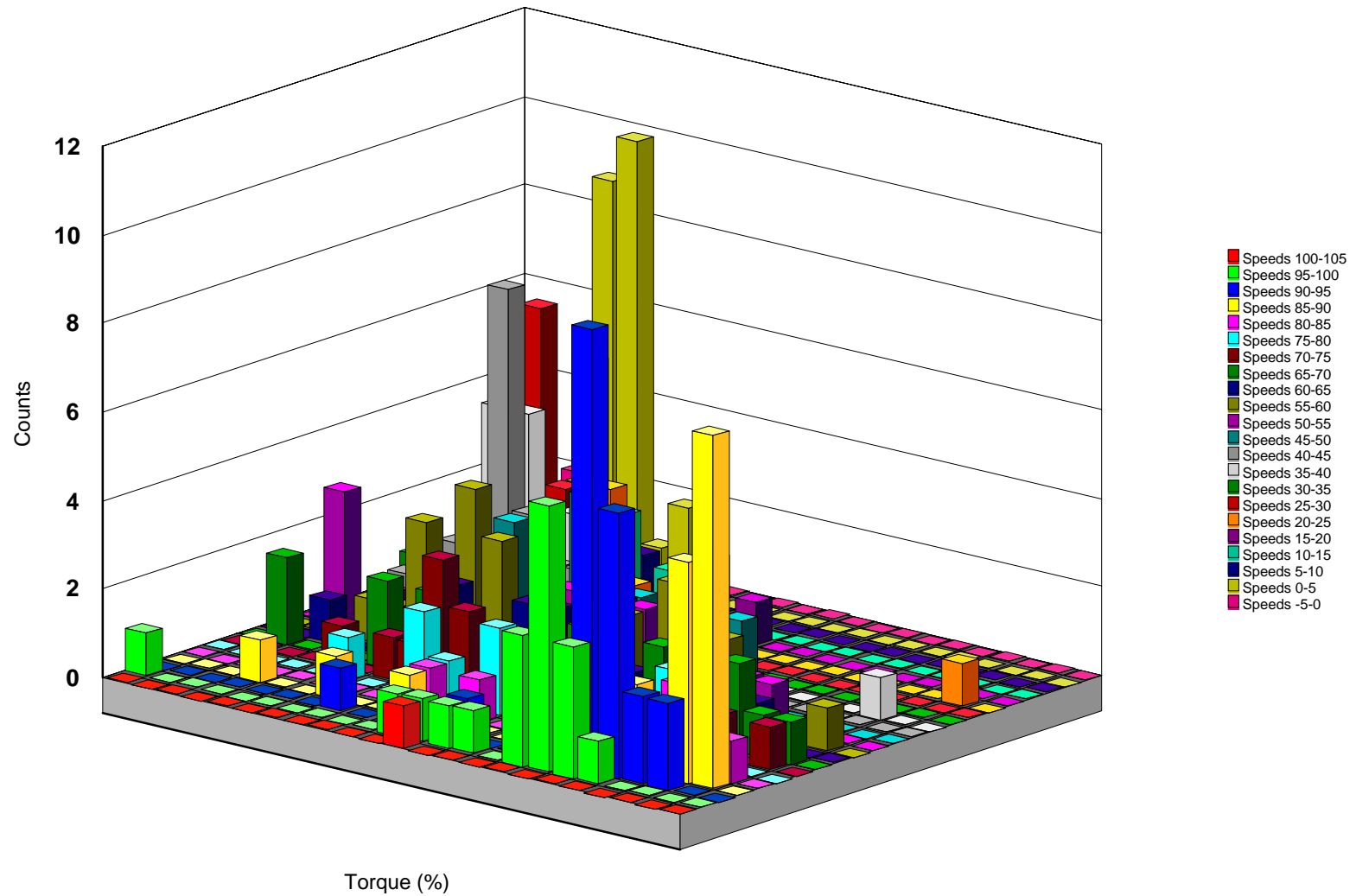
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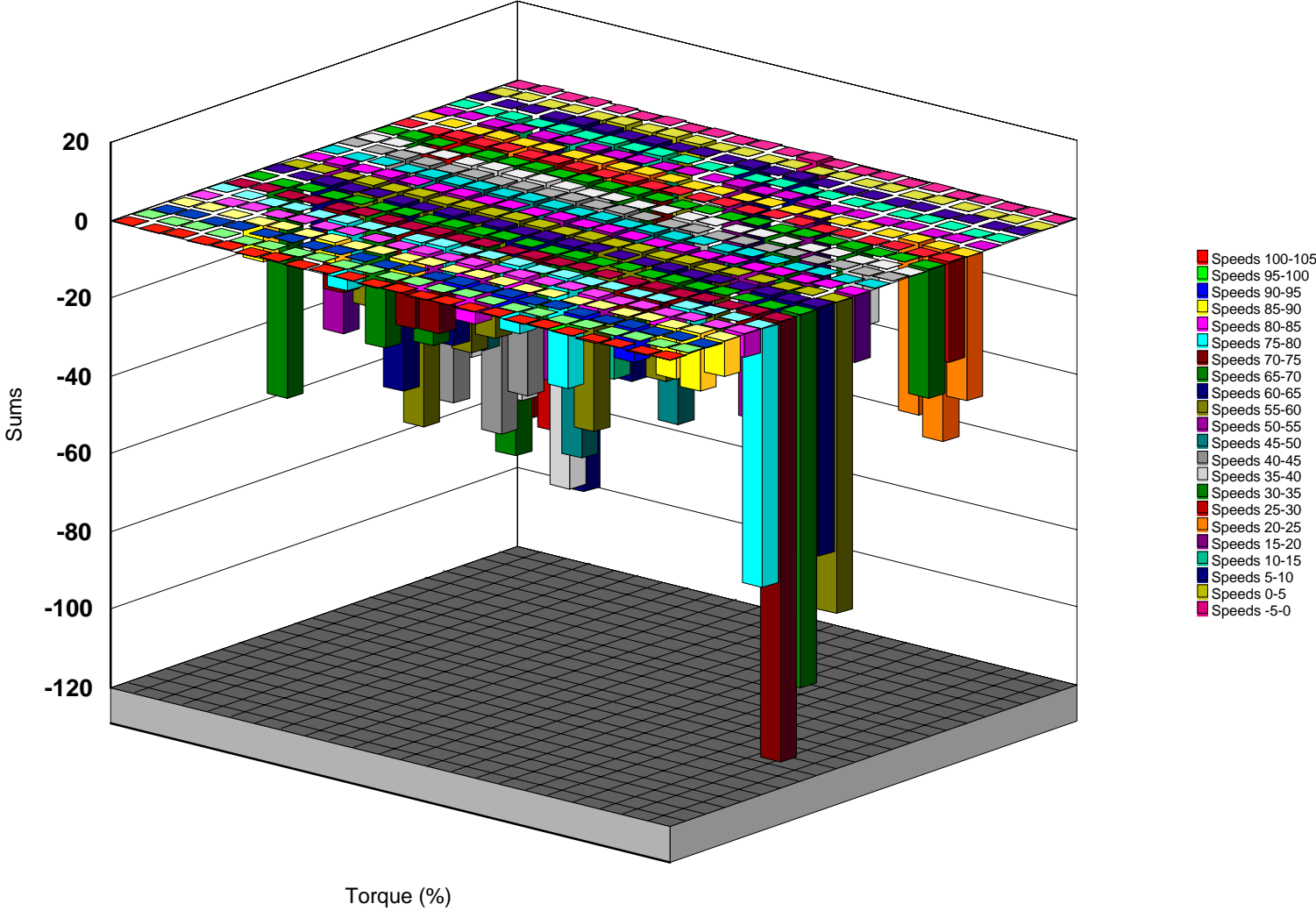
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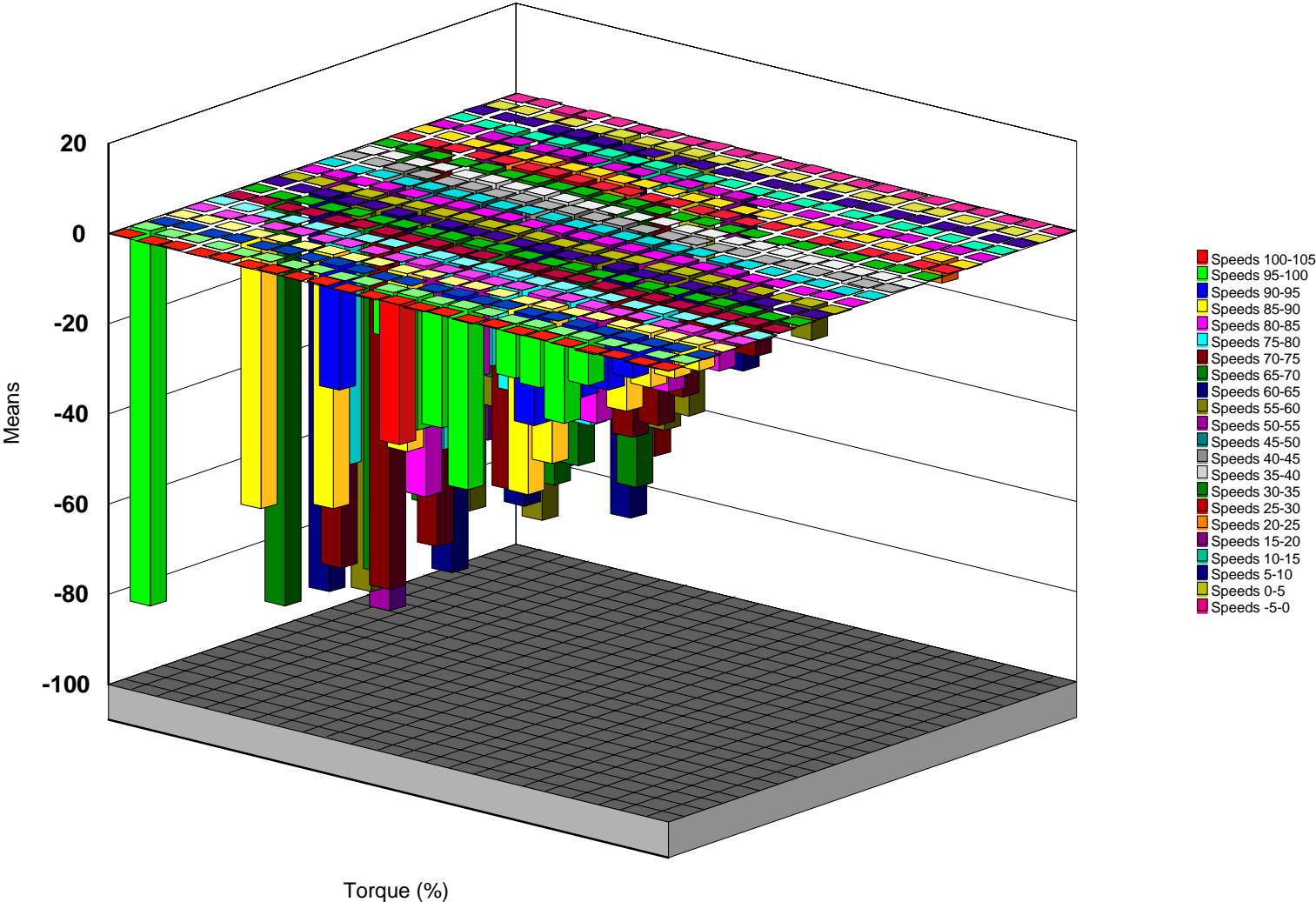
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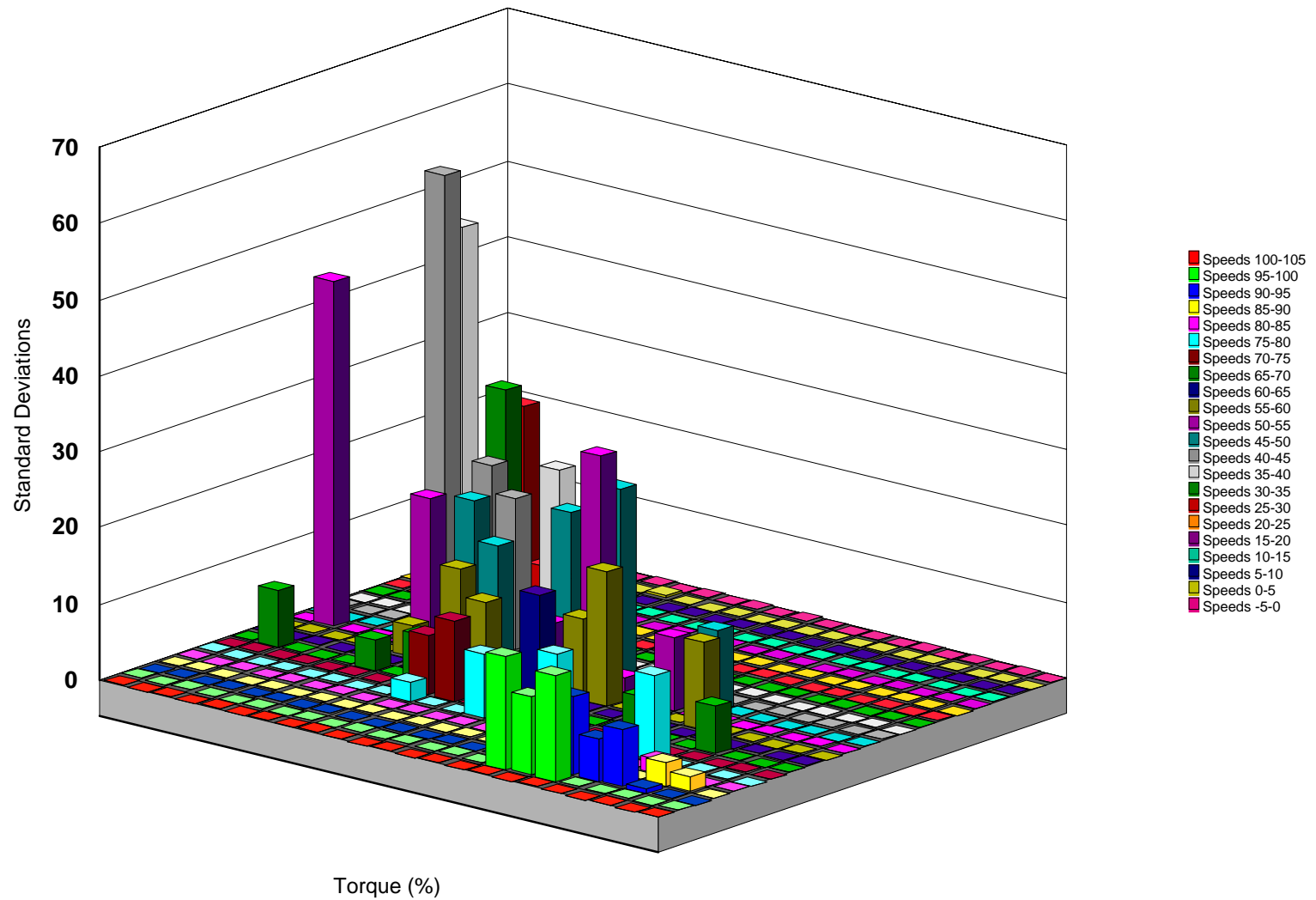
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# WHEEL LOADER TYPICAL 2--Torque Deceleration Mea

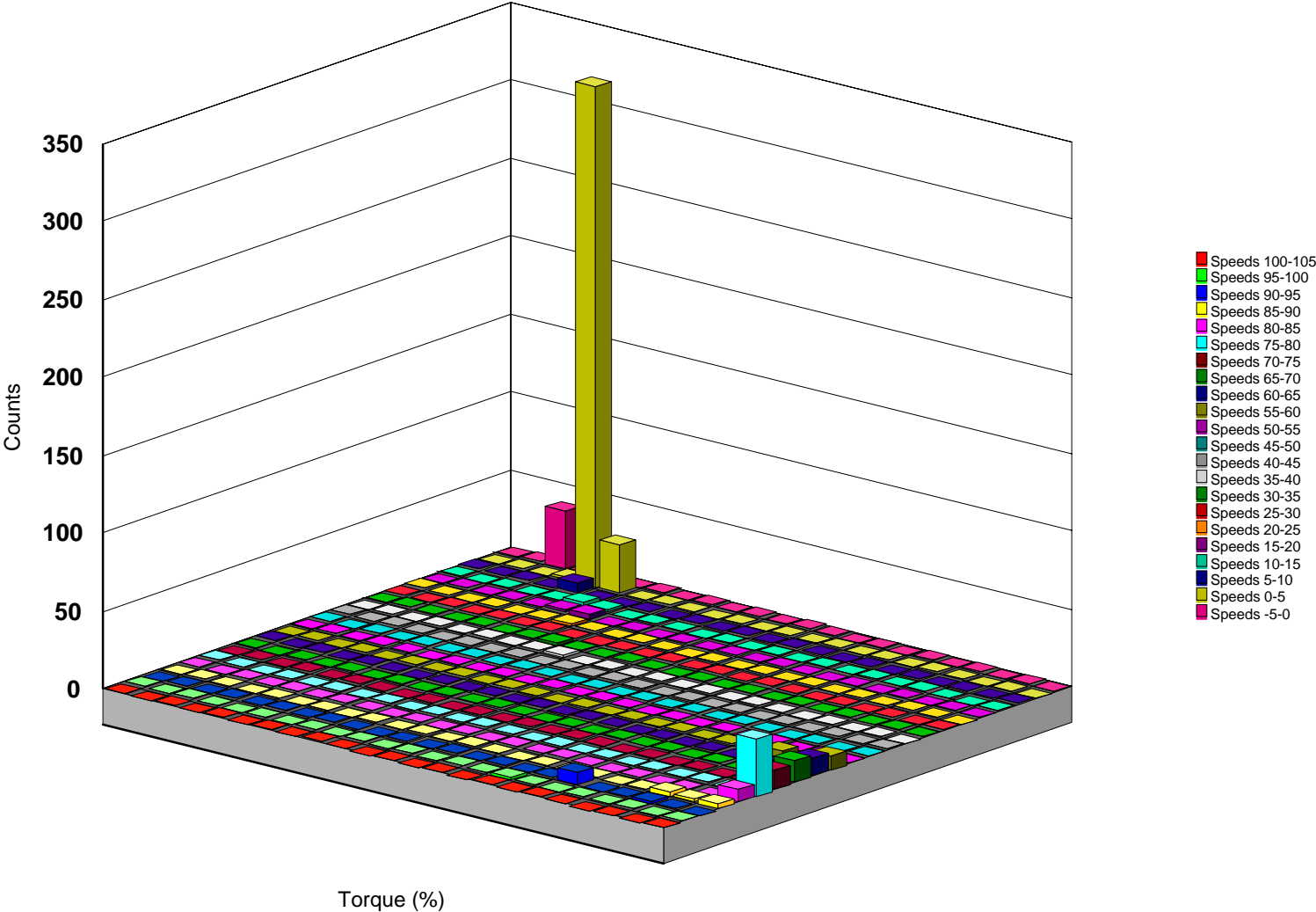


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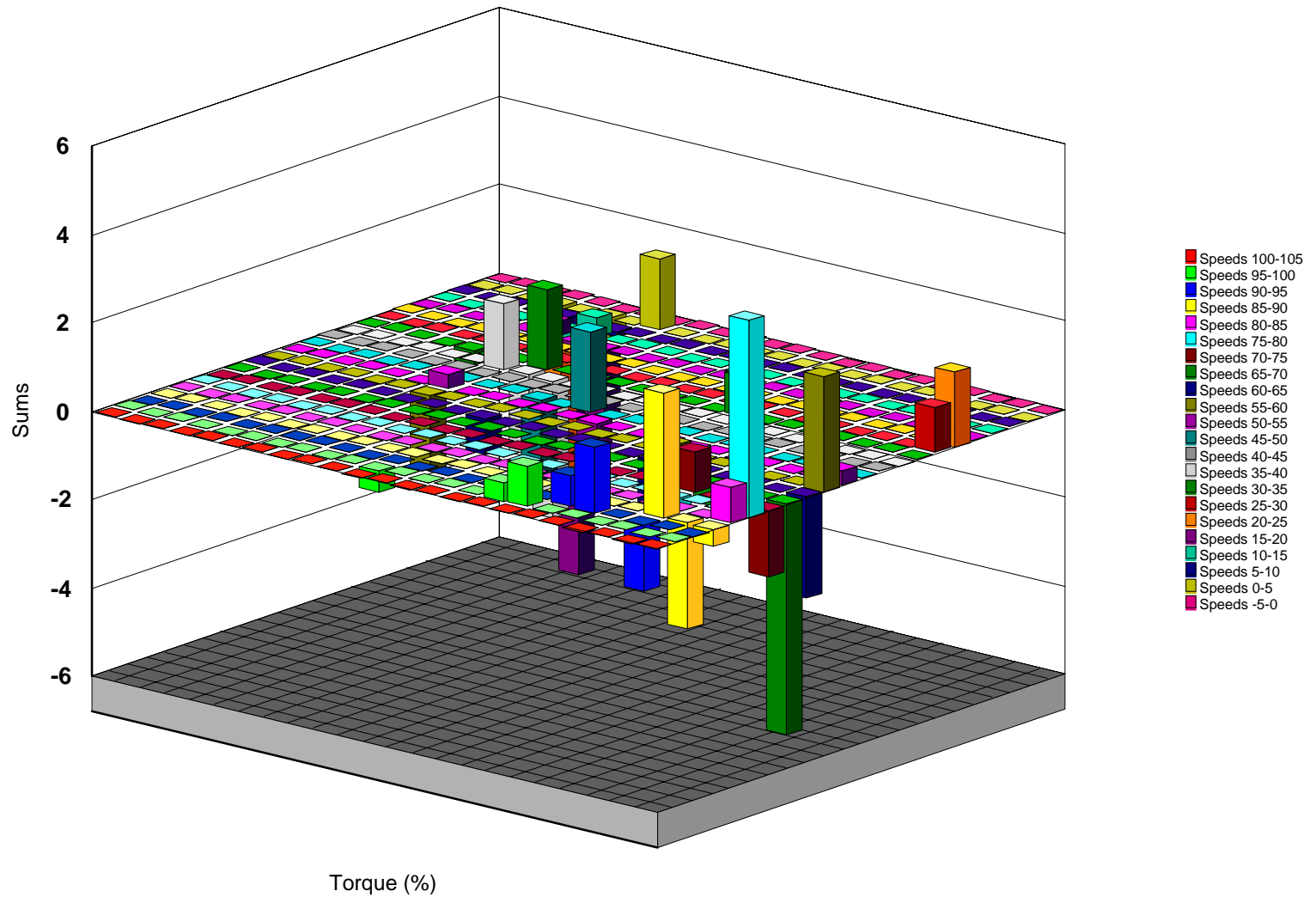




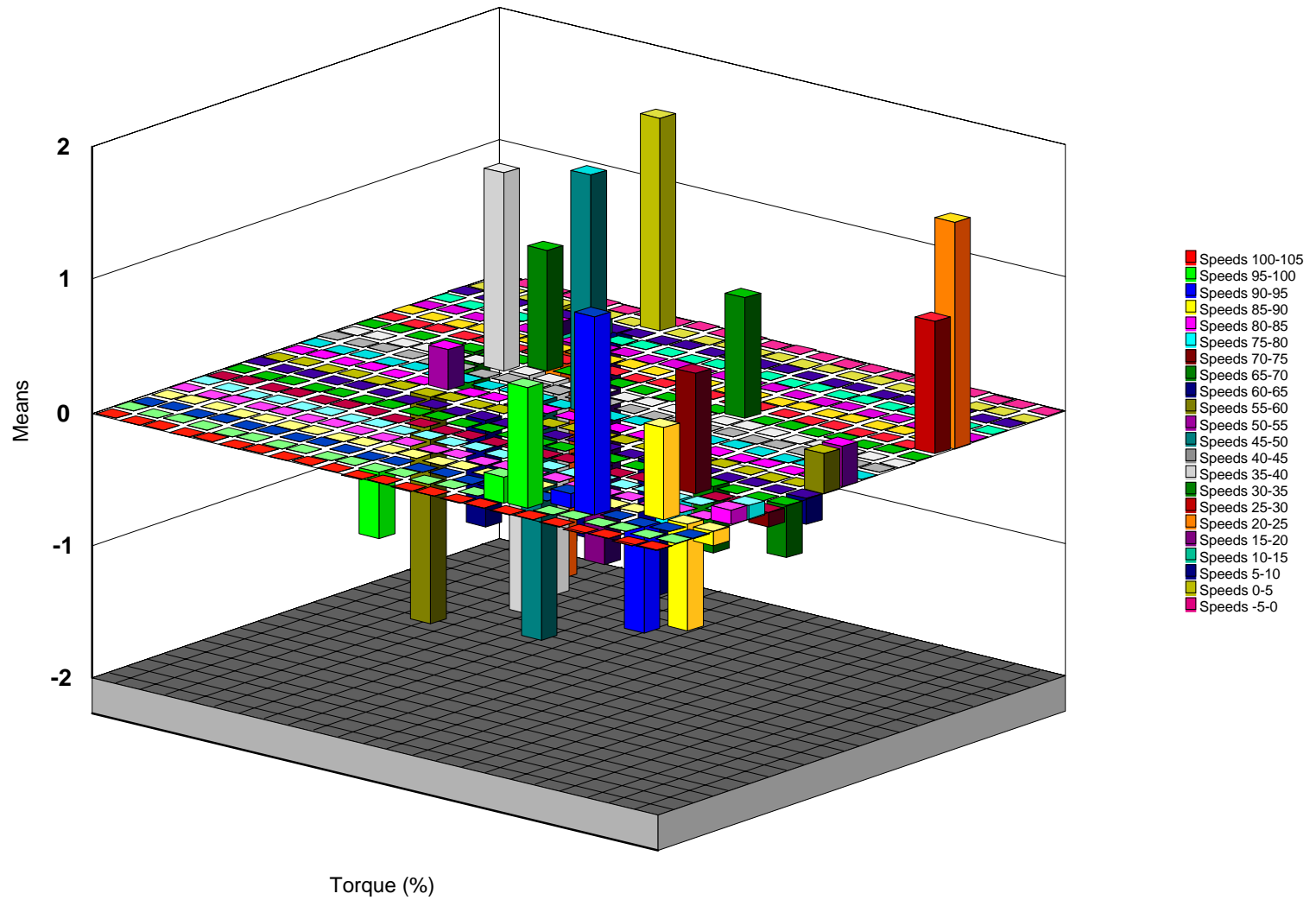
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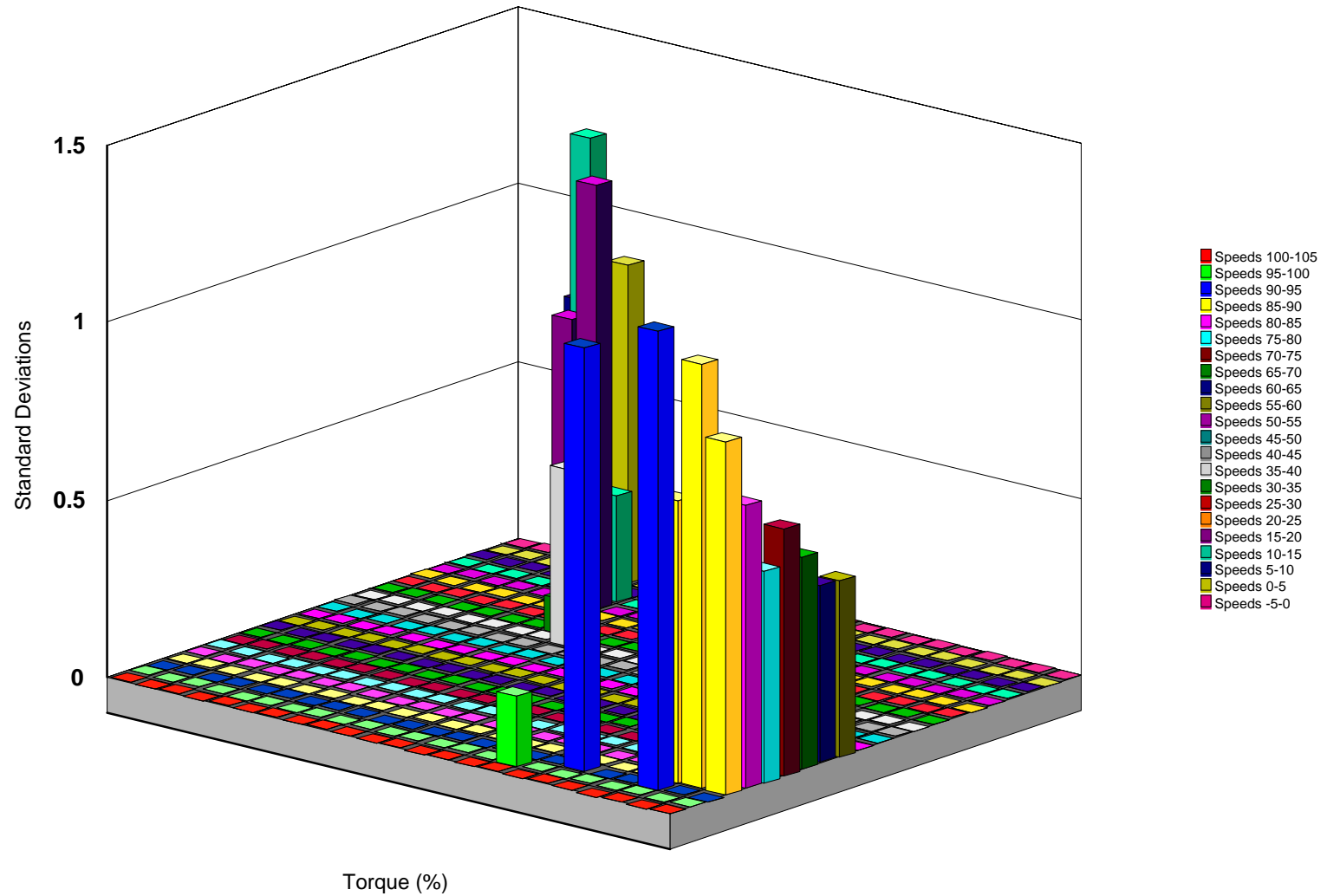
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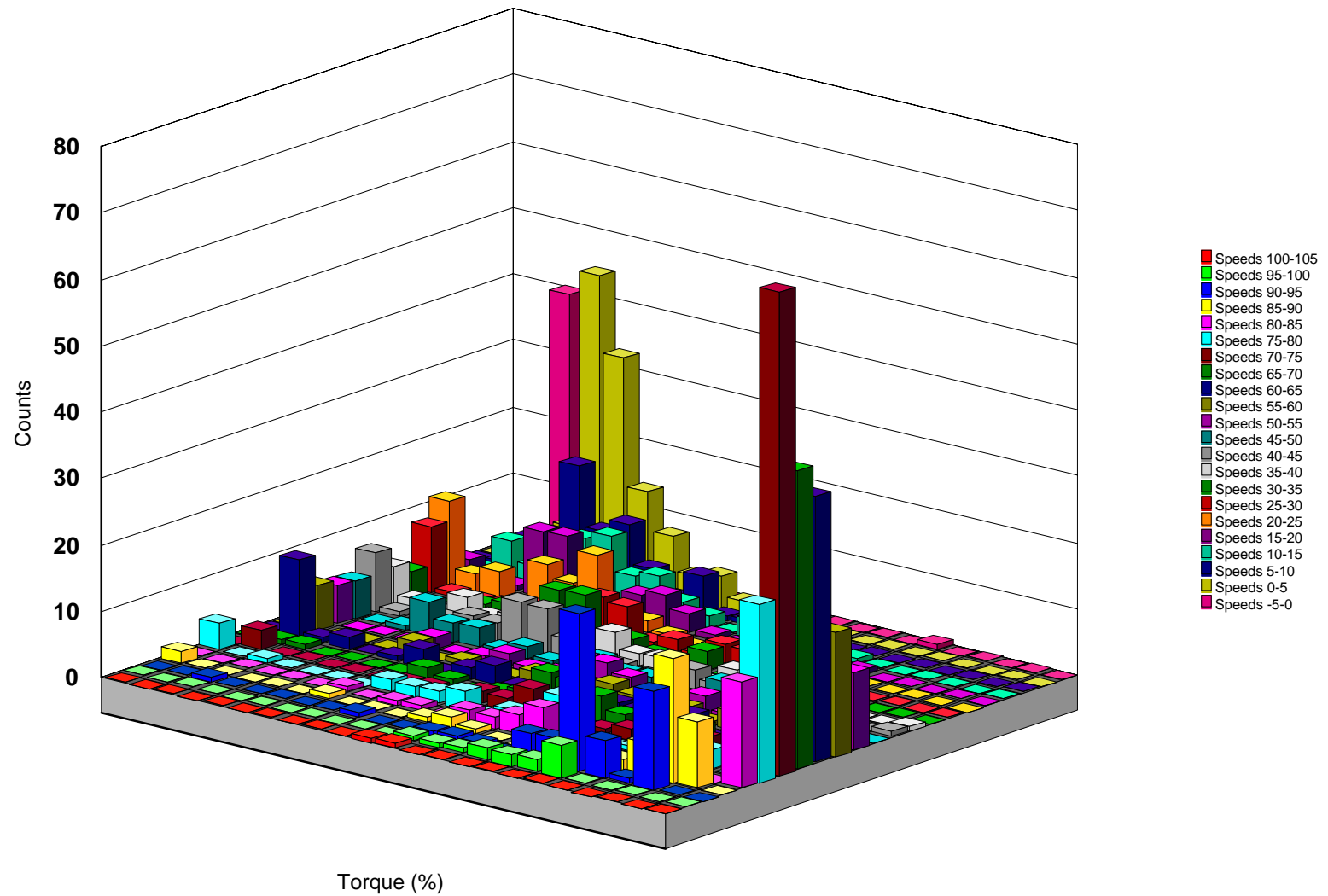
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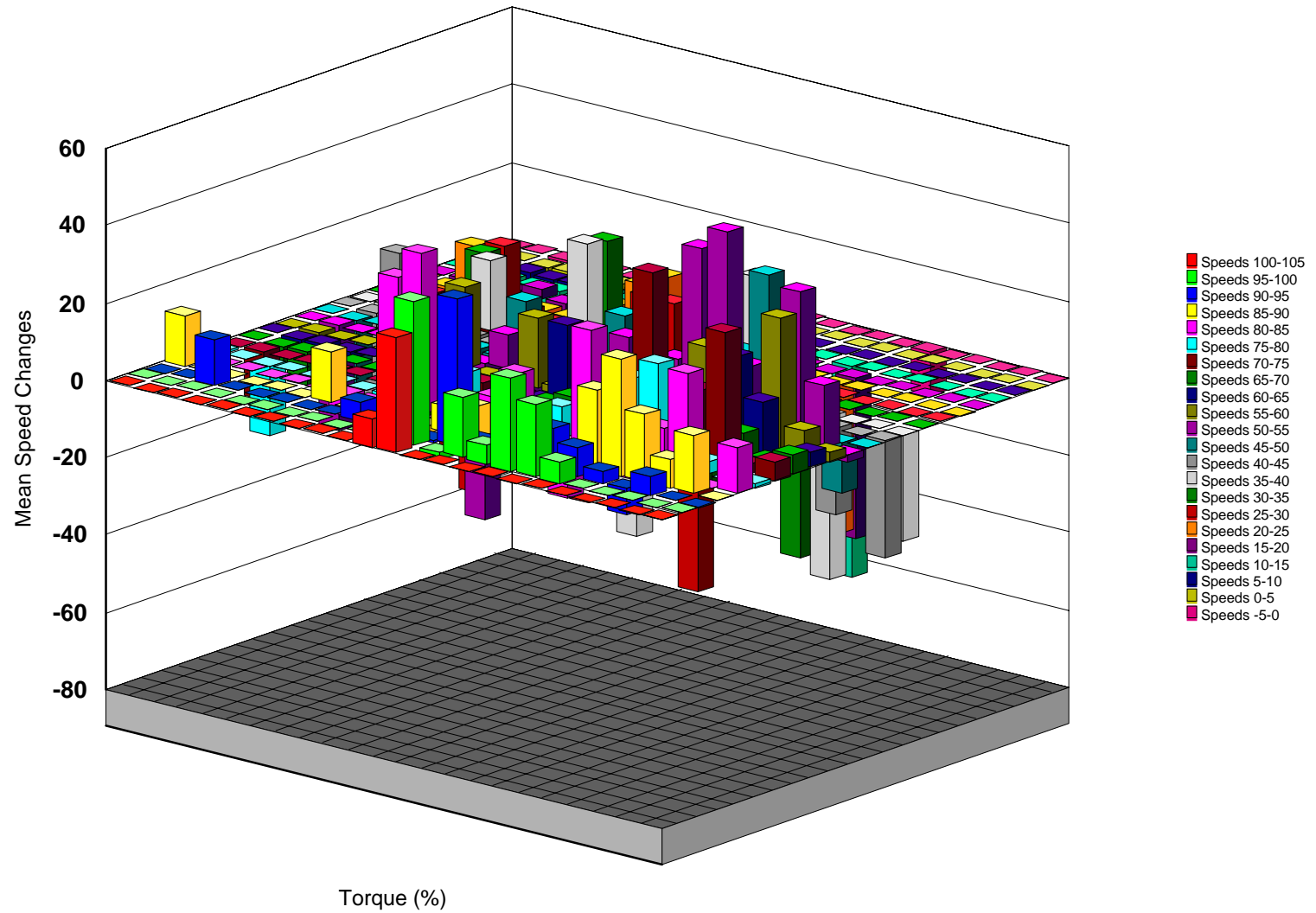
## WHEEL LOADER TYPICAL 2--Torque Steady State Standard Devia



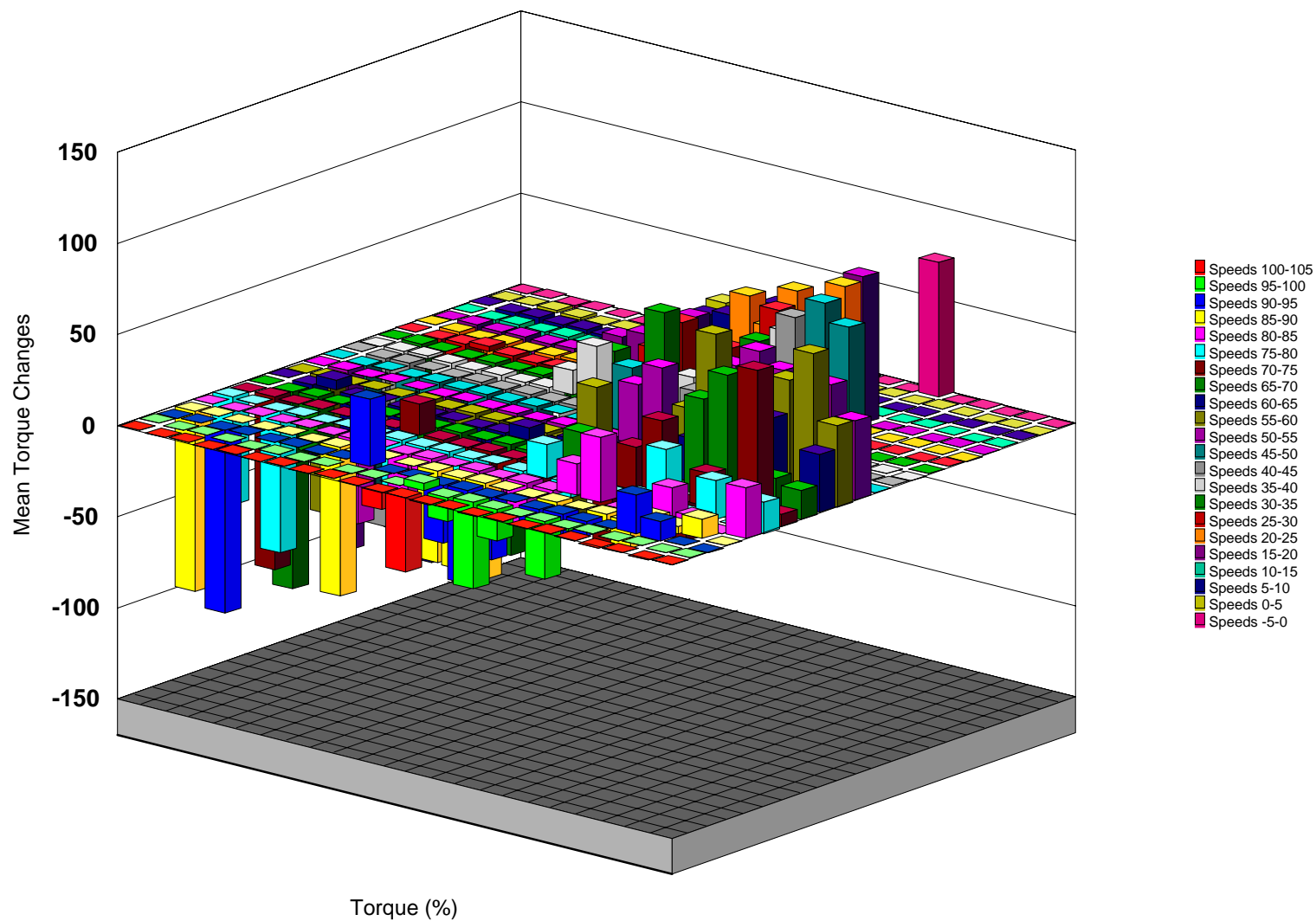
# WHEEL LOADER HIGH SPEED TRANSIENT--Counts



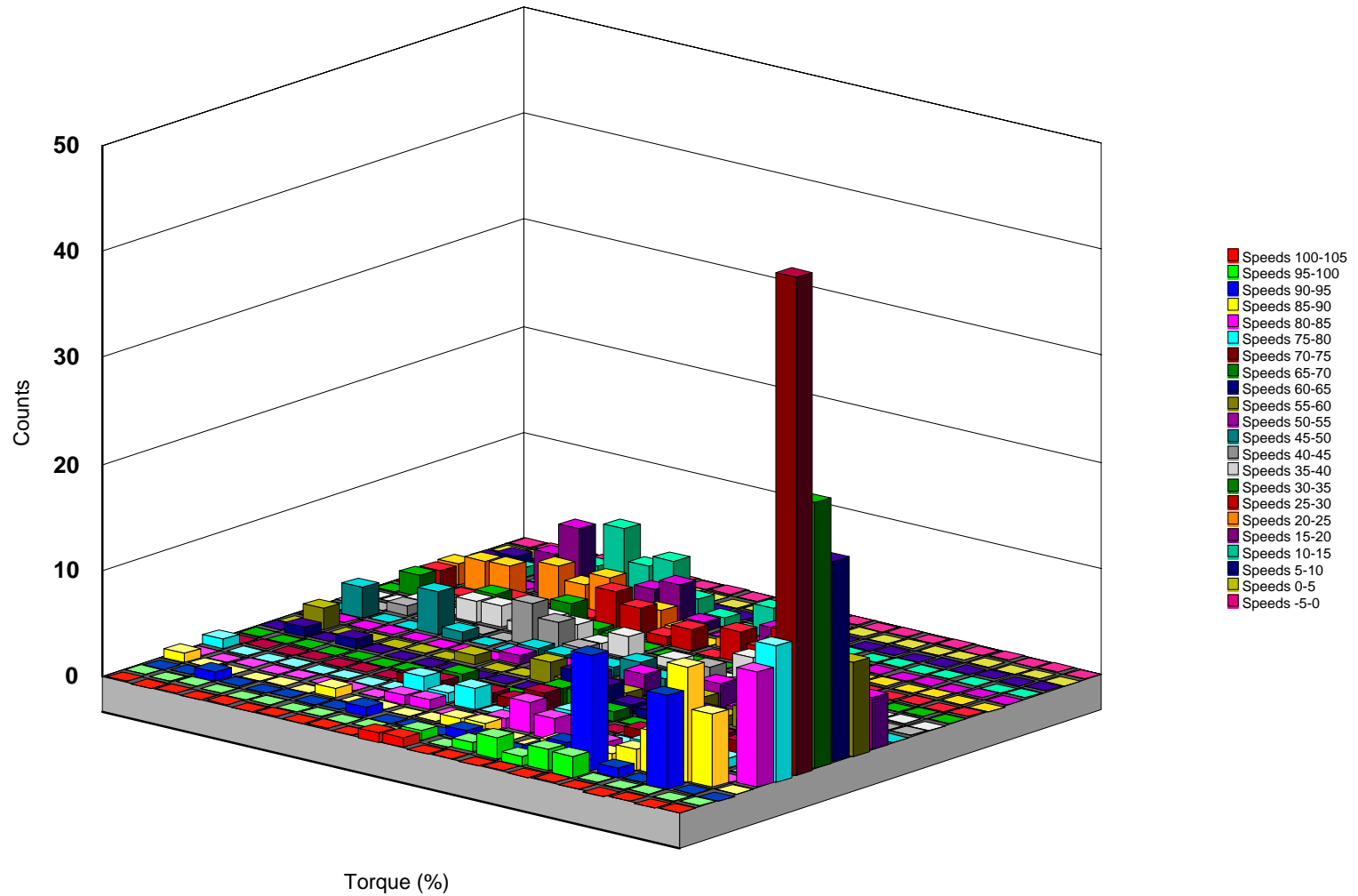
## WHEEL LOADER HIGH SPEED TRANSIENT--Mean Speed C



## WHEEL LOADER HIGH SPEED TRANSIENT--Mean Torque C

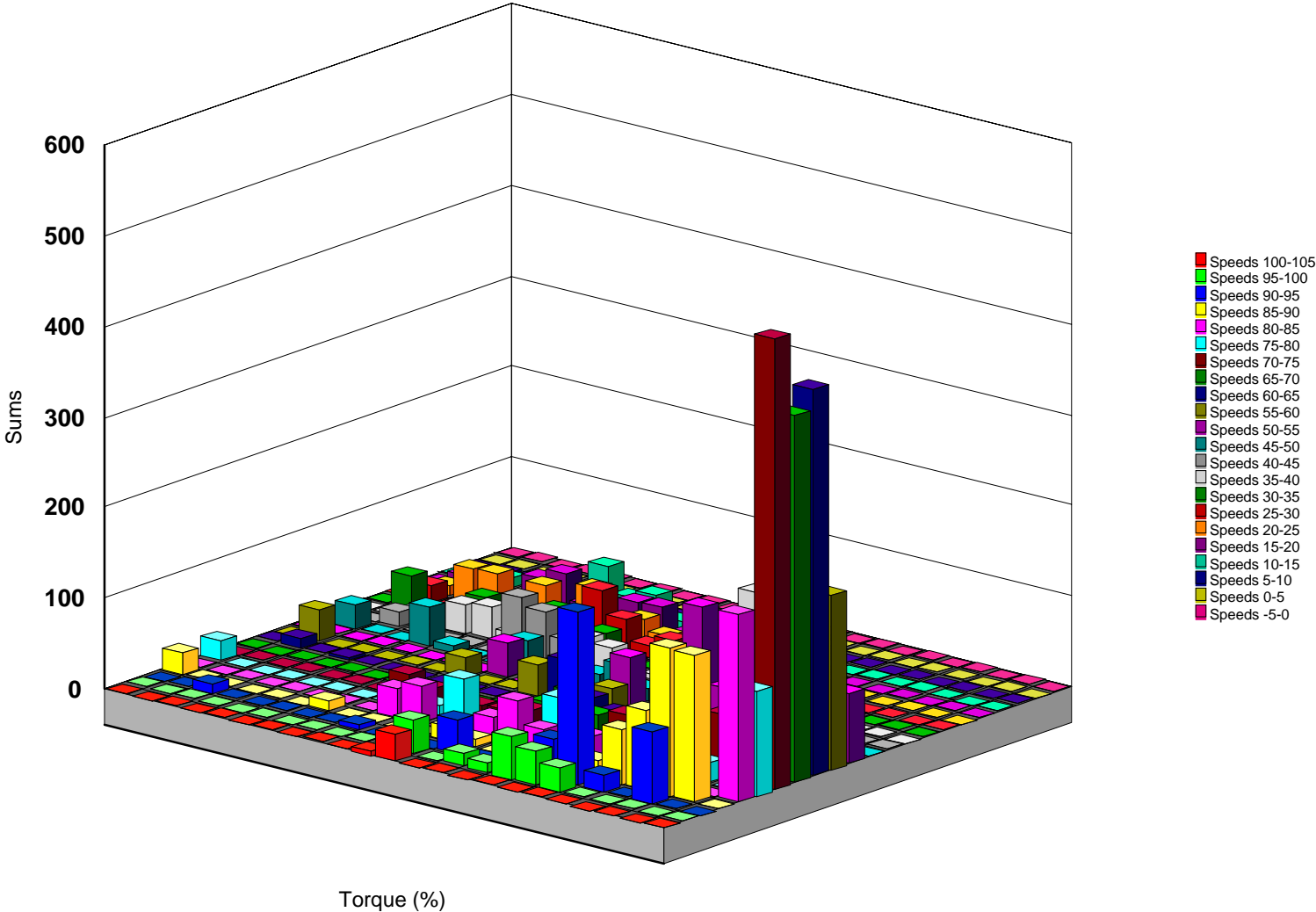


## WHEEL LOADER HIGH SPEED TRANSIENT--Speed Acceleration Co

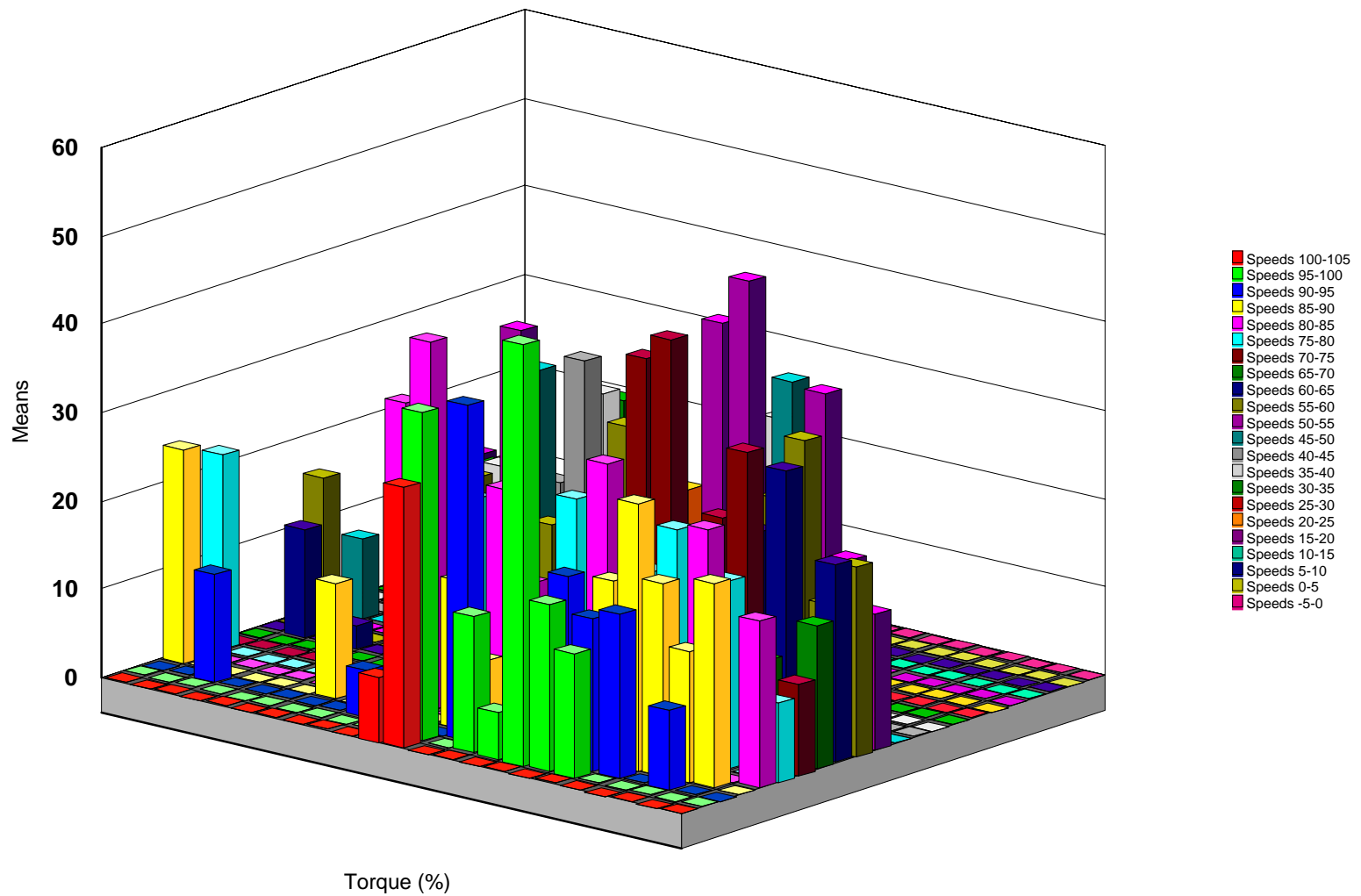




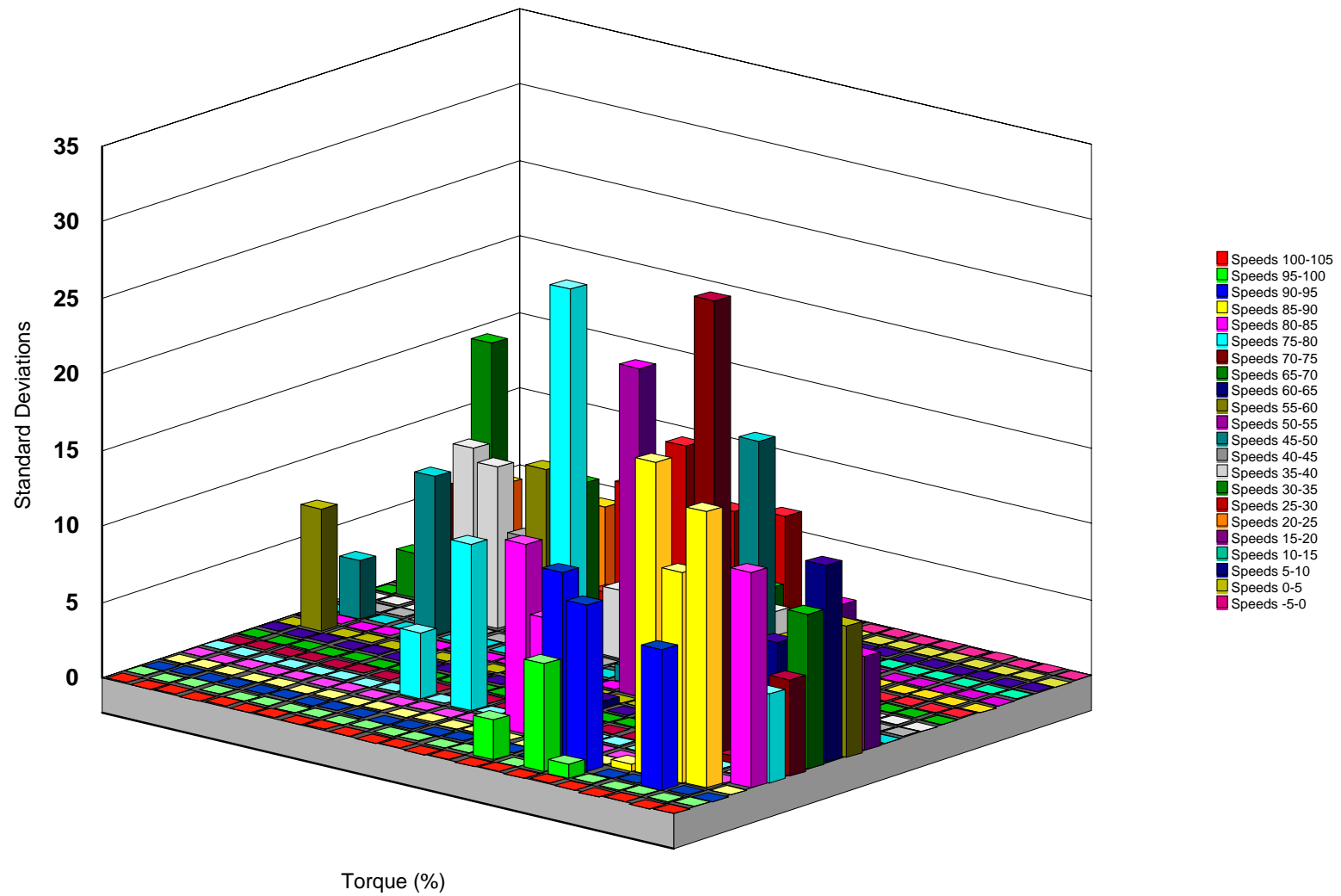
# WHEEL LOADER HIGH SPEED TRANSIENT--Speed Acceleration



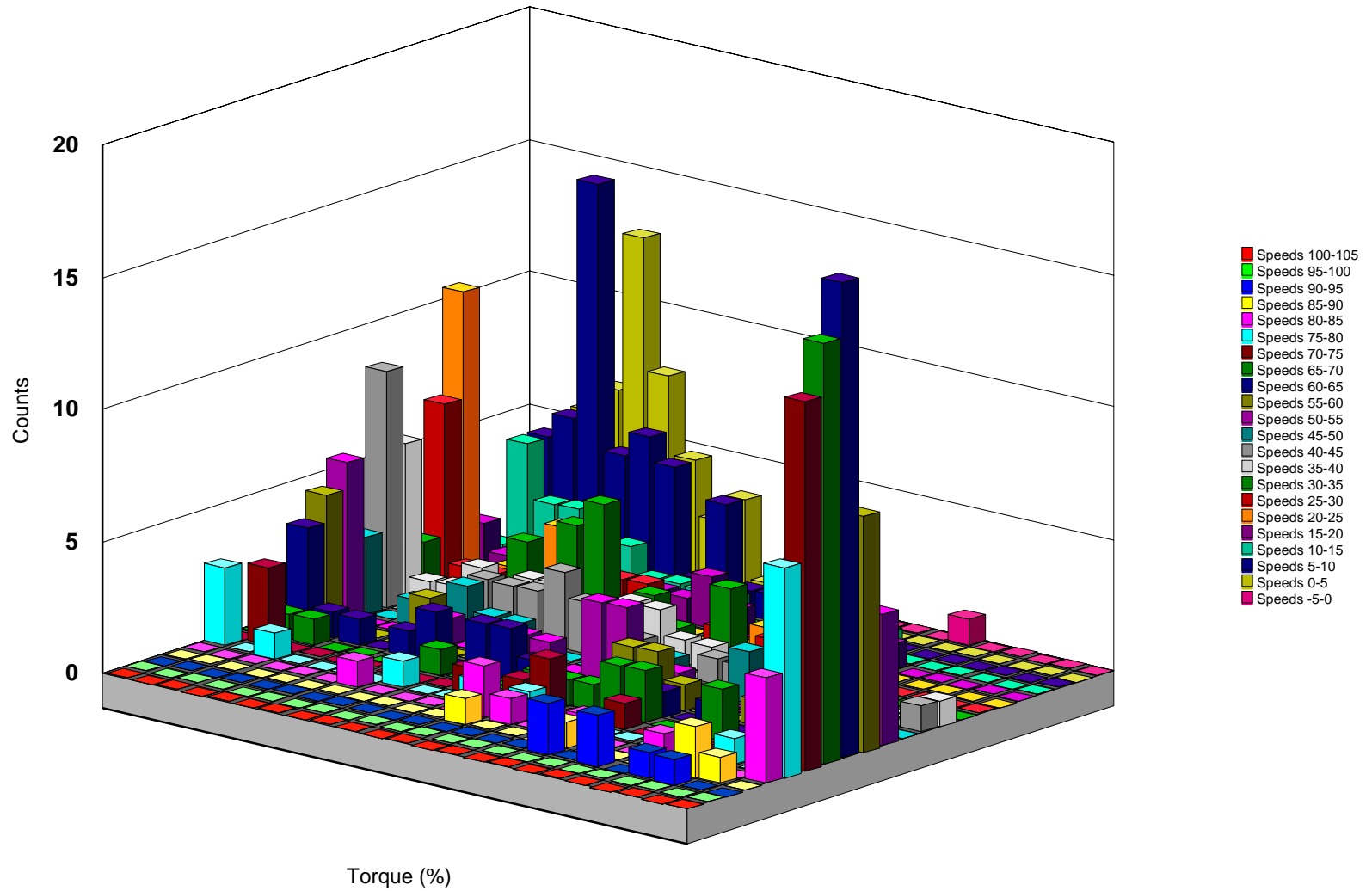
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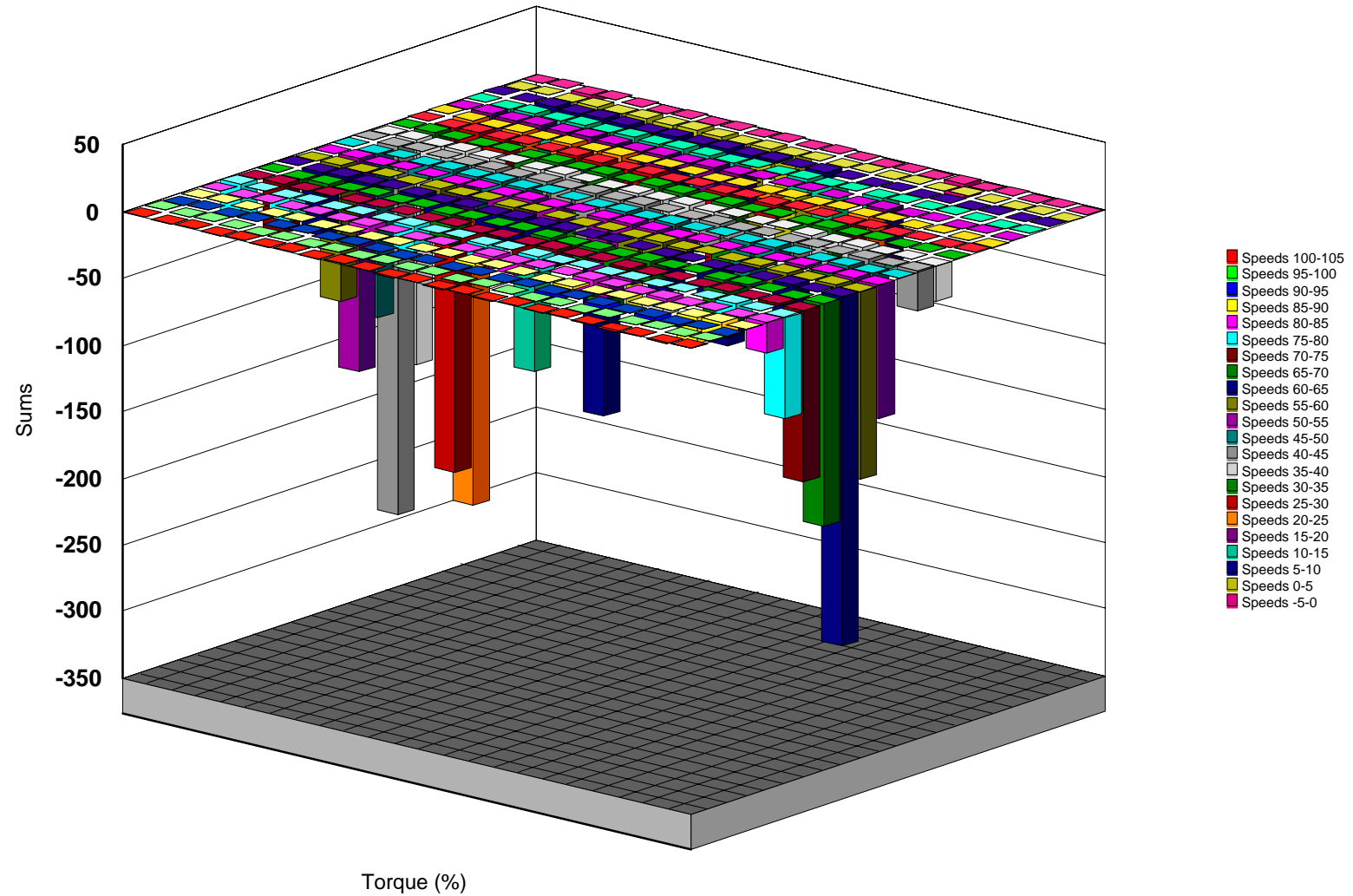
## WHEEL LOADER HIGH SPEED TRANSIENT--Speed Acceleration Standard Deviation



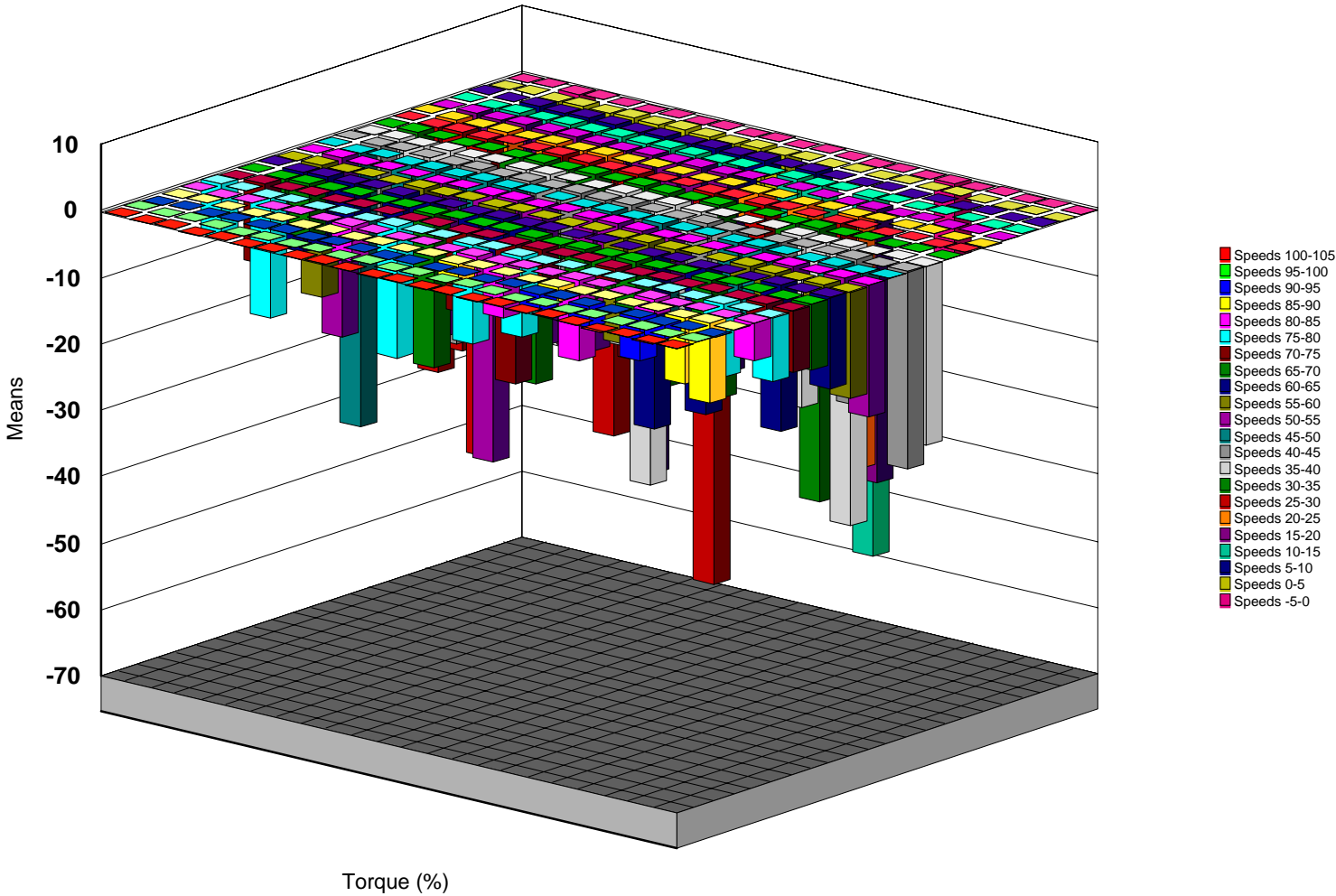
## WHEEL LOADER HIGH SPEED TRANSIENT--Speed Deceleration Cour



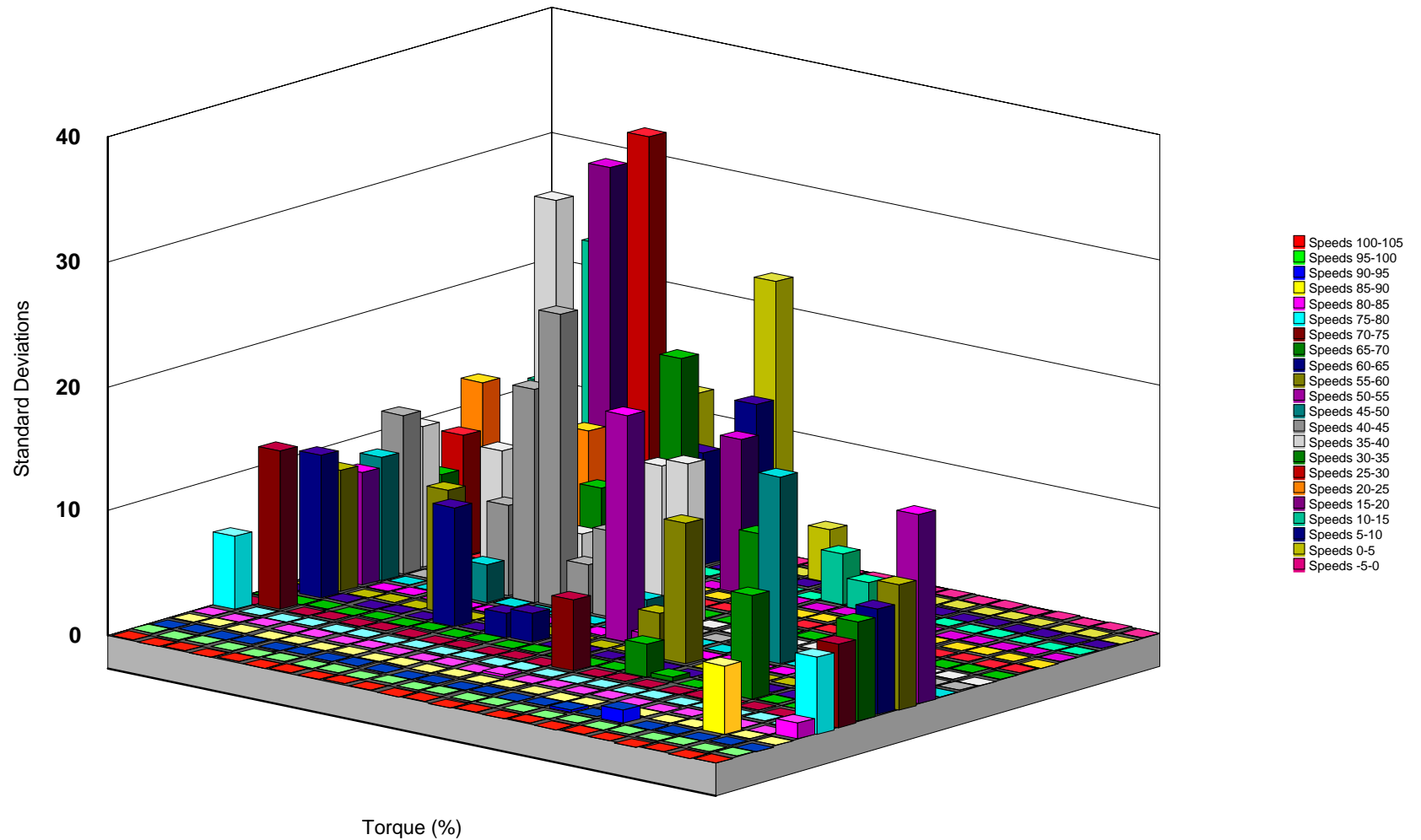
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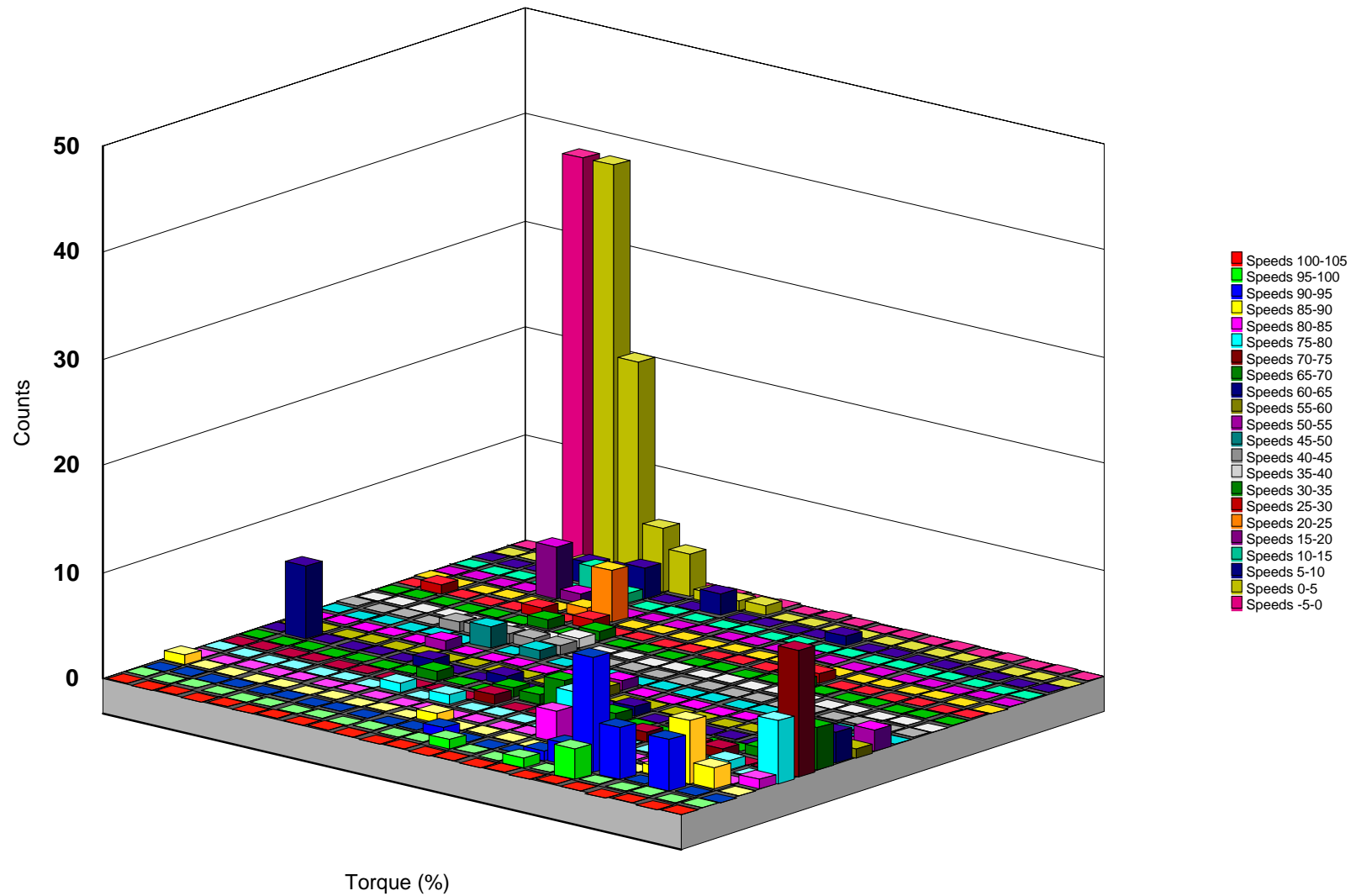
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## WHEEL LOADER HIGH SPEED TRANSIENT--Speed Deceleration Standard Deviations

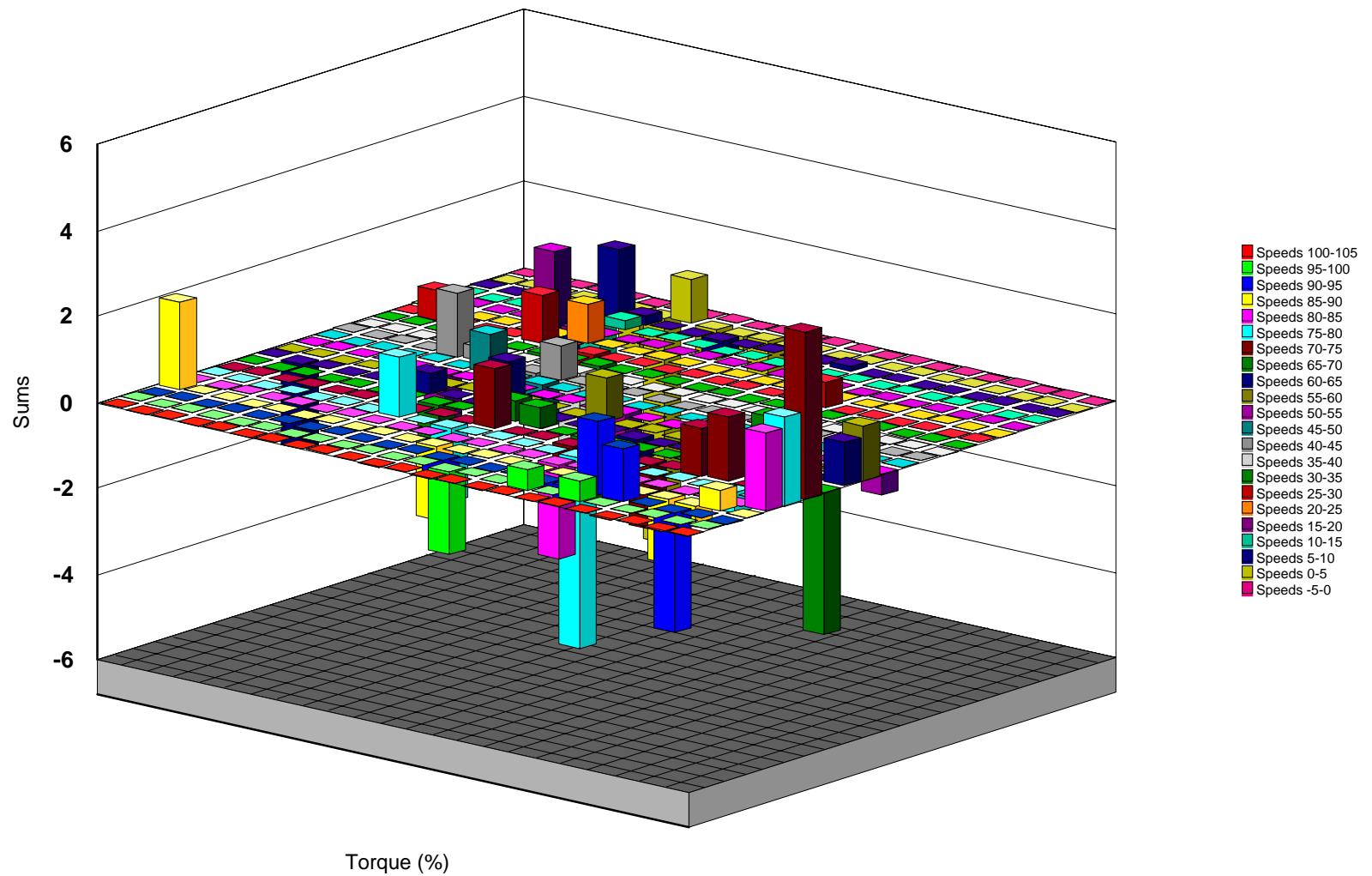


## WHEEL LOADER HIGH SPEED TRANSIENT--Speed Steady State Counts

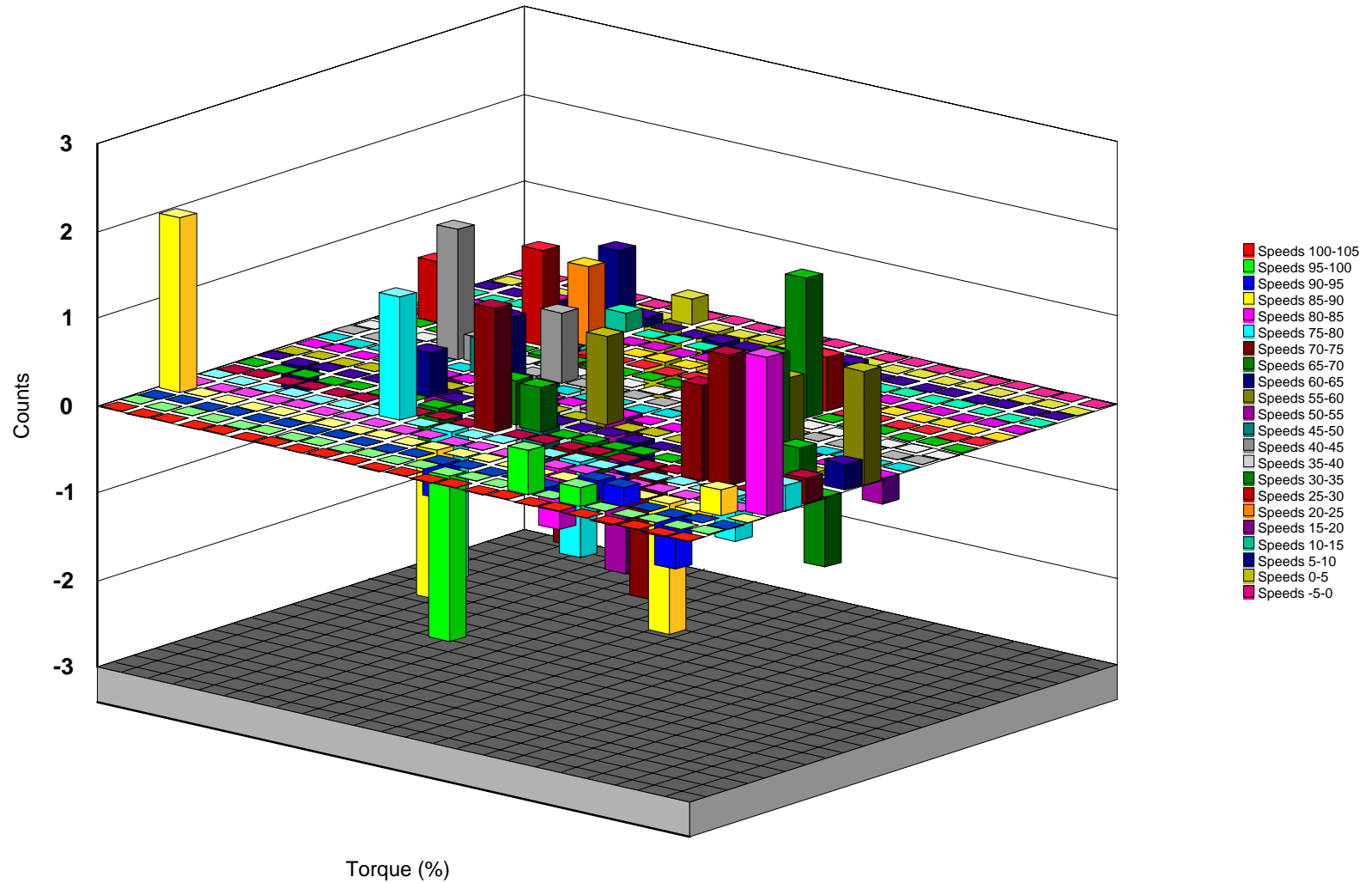




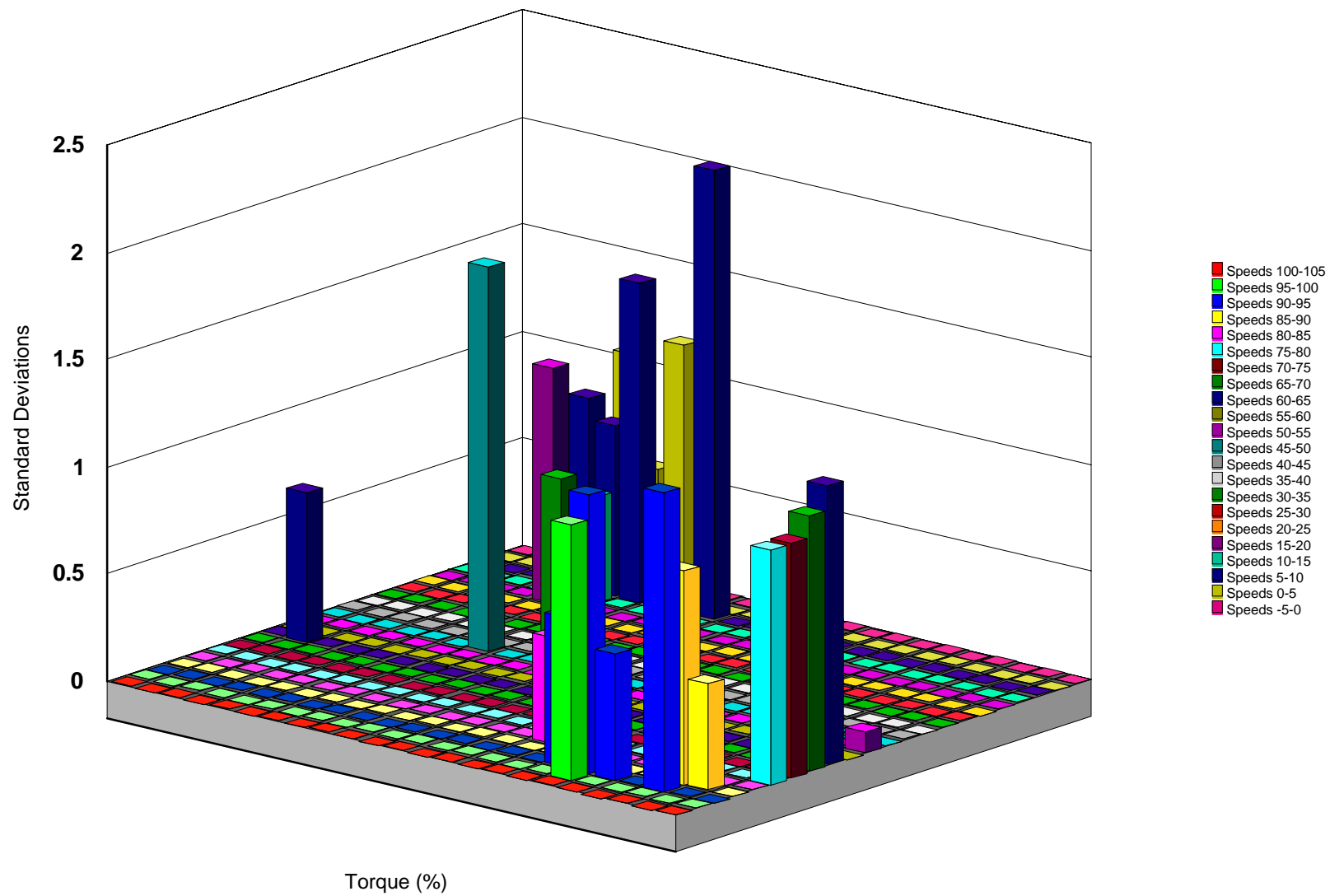
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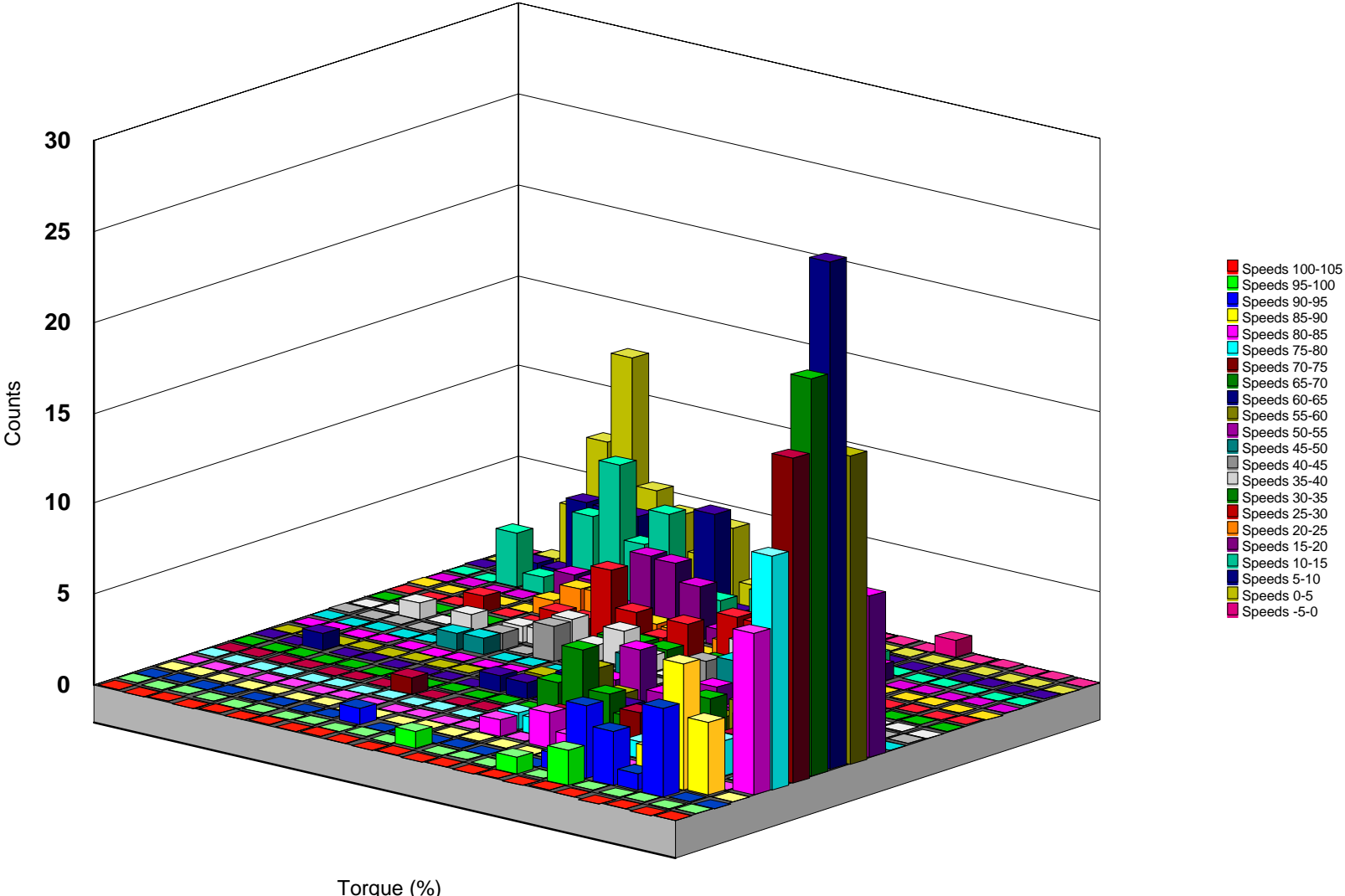
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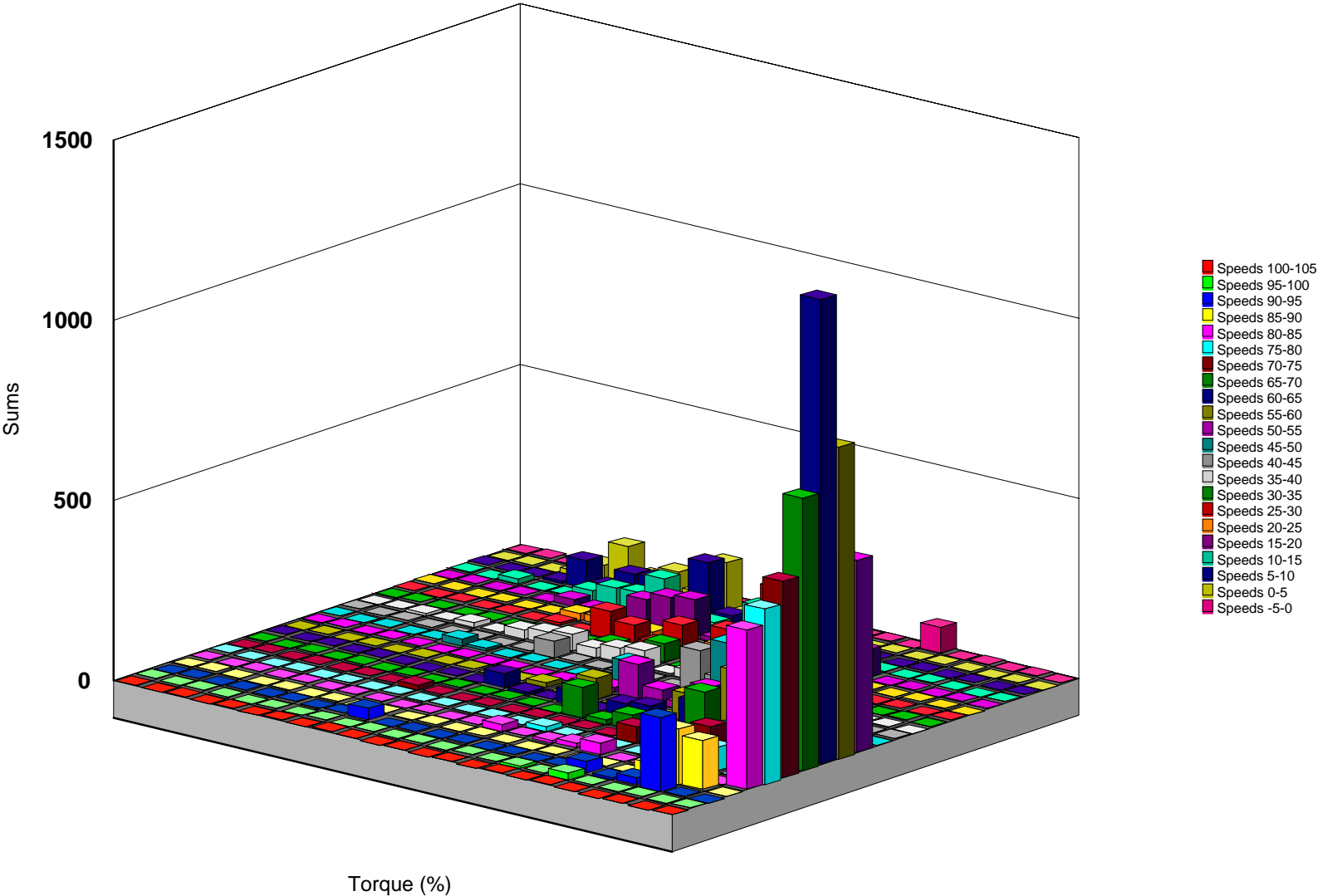
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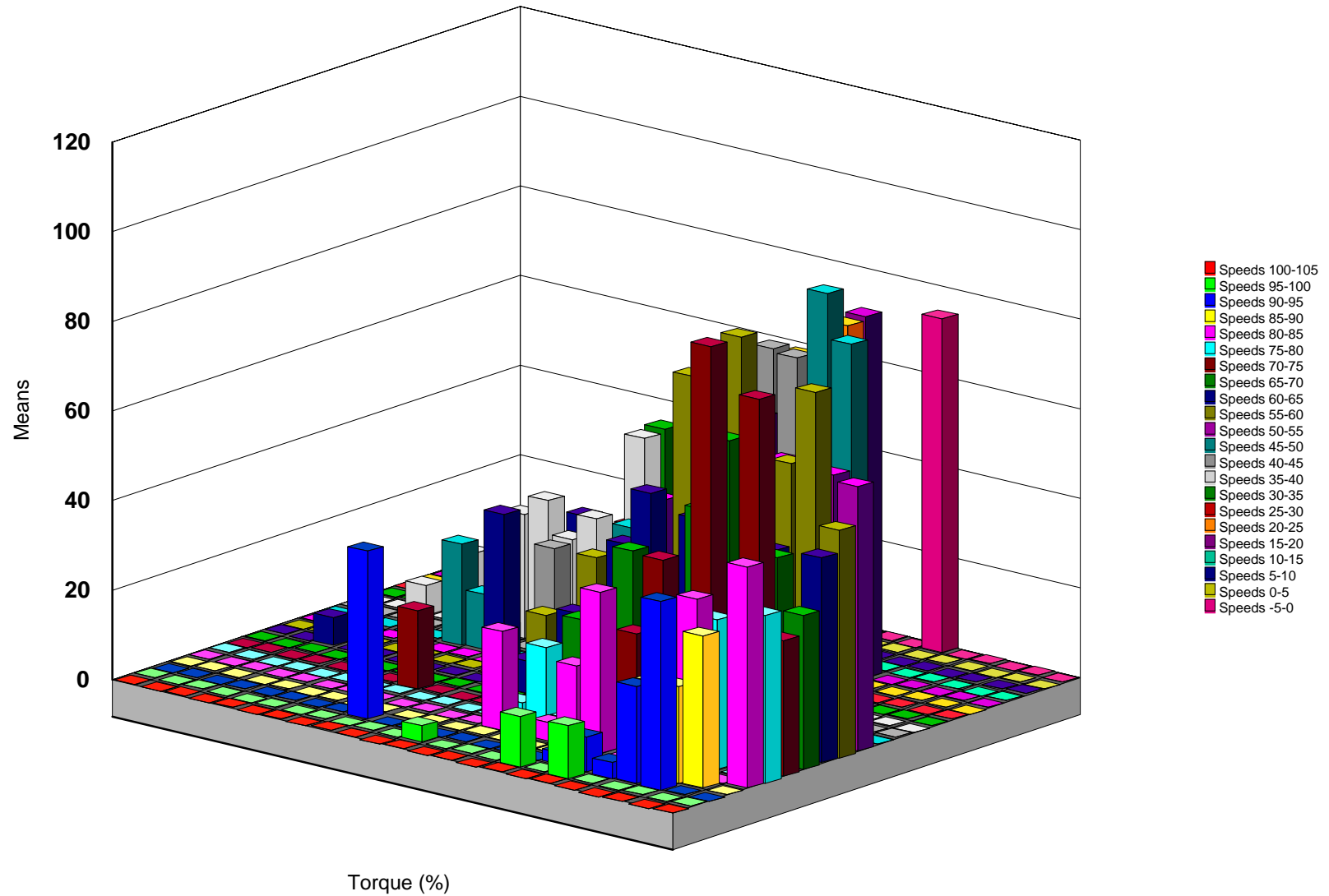
## WHEEL LOADER HIGH SPEED TRANSIENT--Torque Acceleration Counts



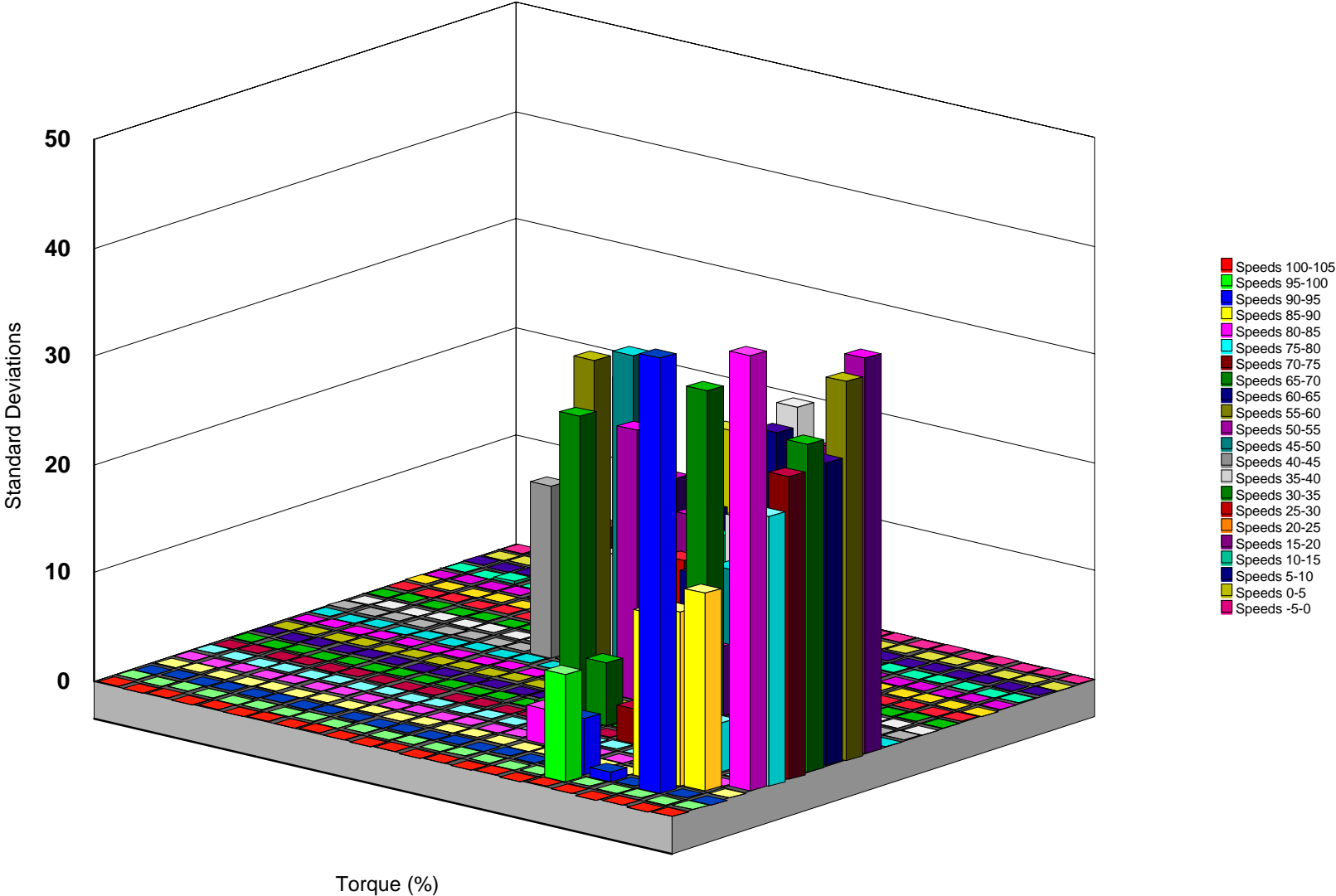
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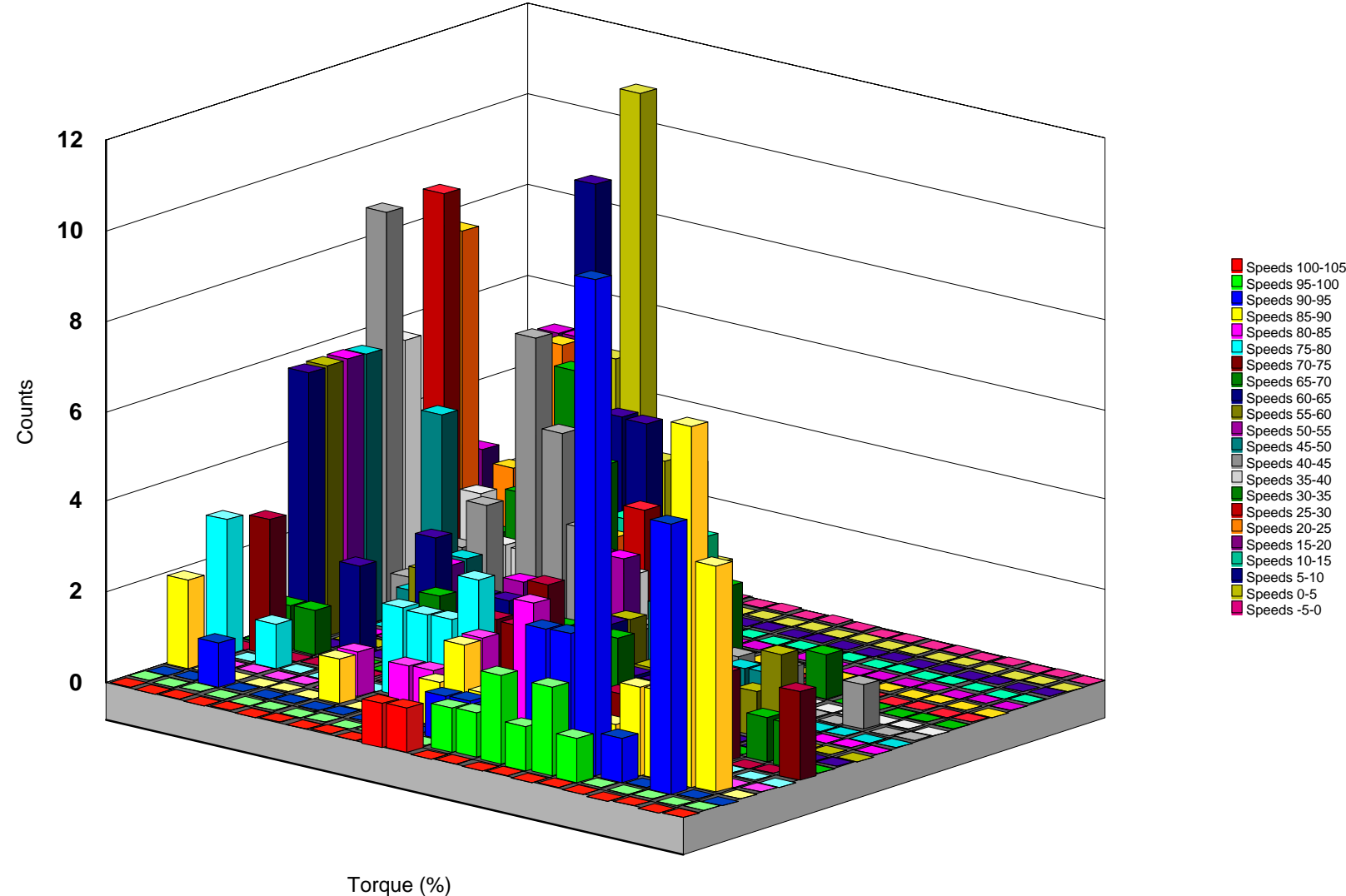
WHEEL LOADER HIGH SPEED TRANSIENT--Torque Acceleration Means



WHEEL LOADER HIGH SPEED TRANSIENT--Torque Acceleration Standard Deviations

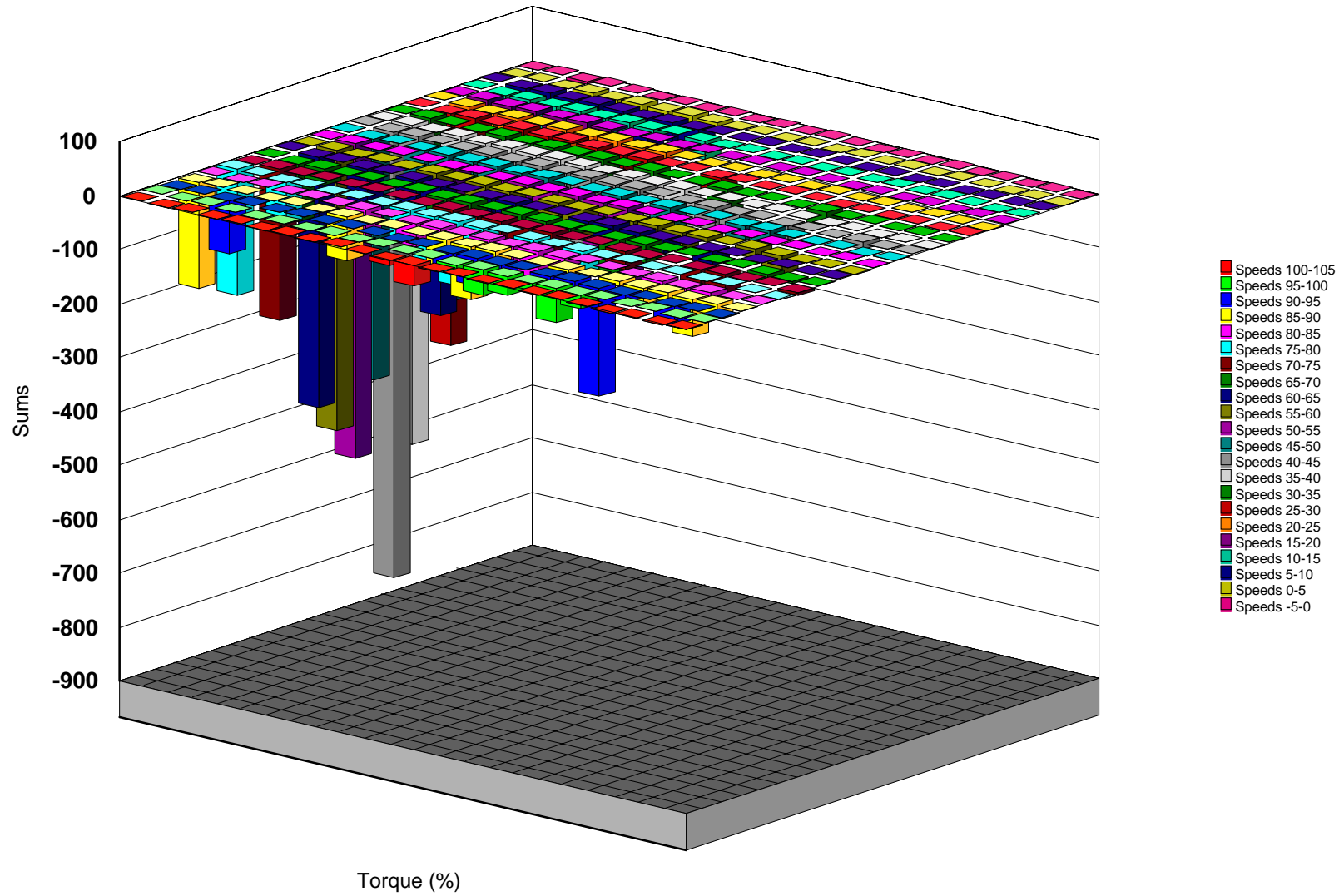


WHEEL LOADER HIGH SPEED TRANSIENT--Torque Deceleration Counts



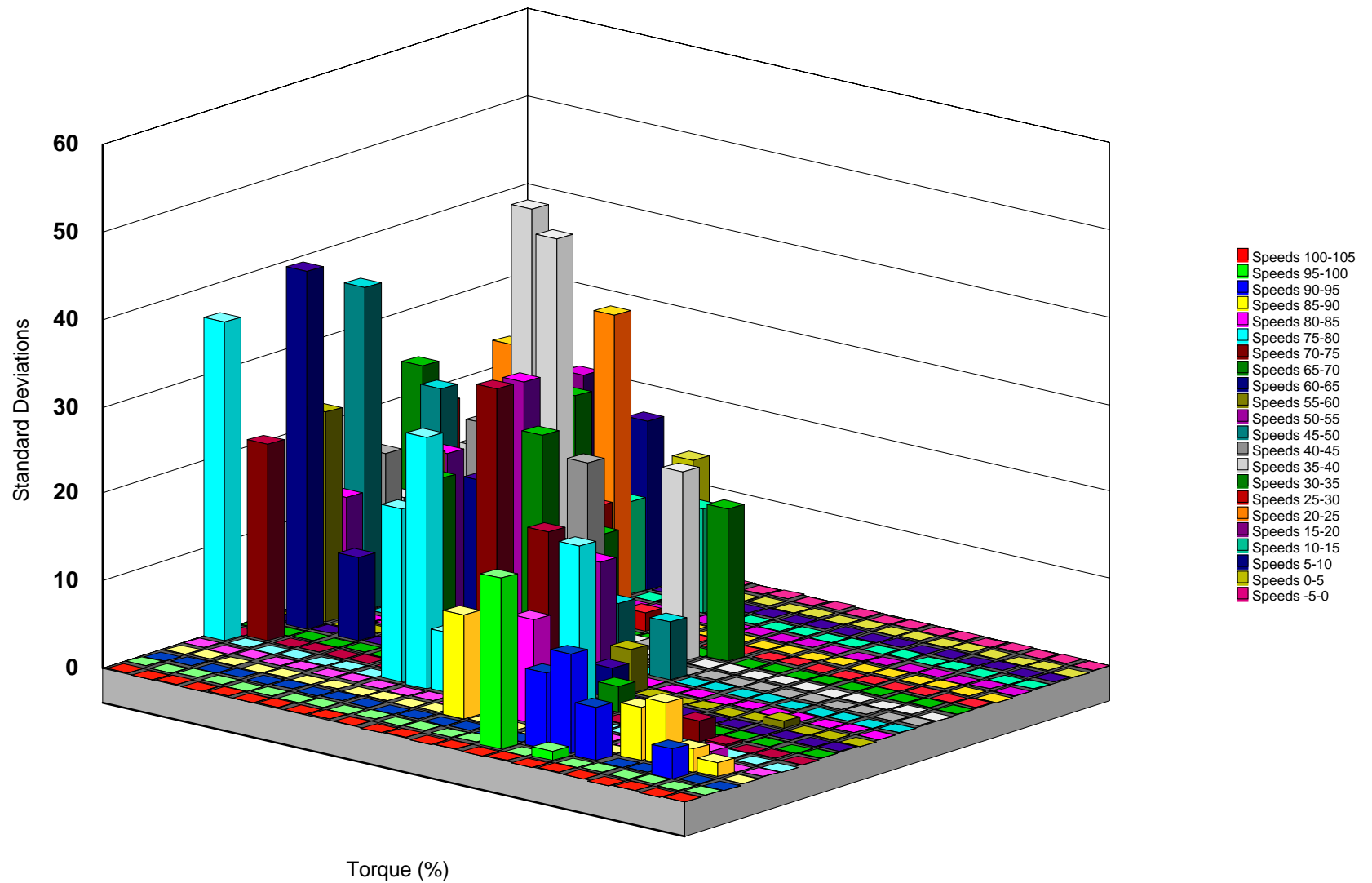


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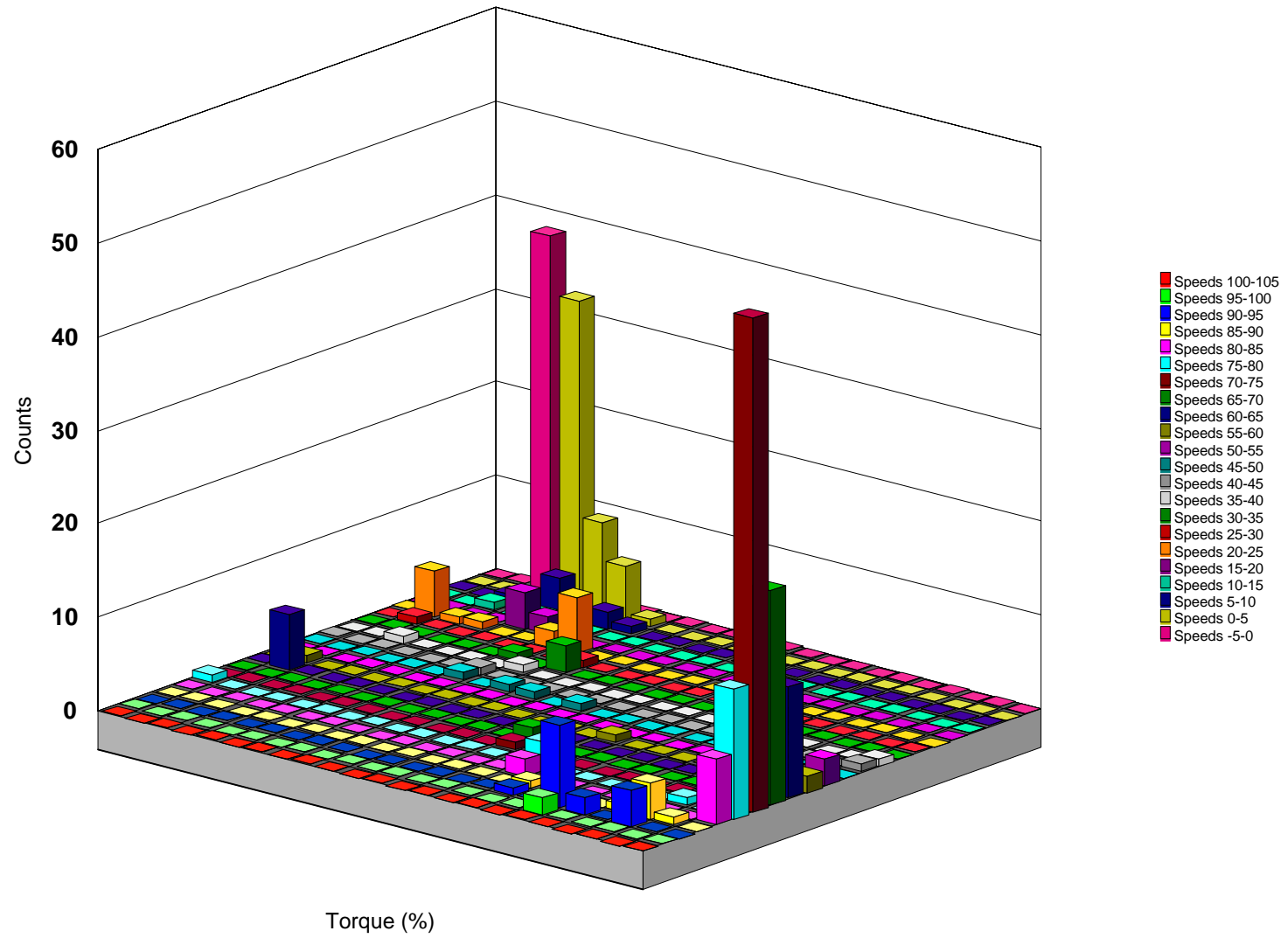


WHEEL LOADER HIGH SPEED TRANSIENT--Torque Deceleration Means

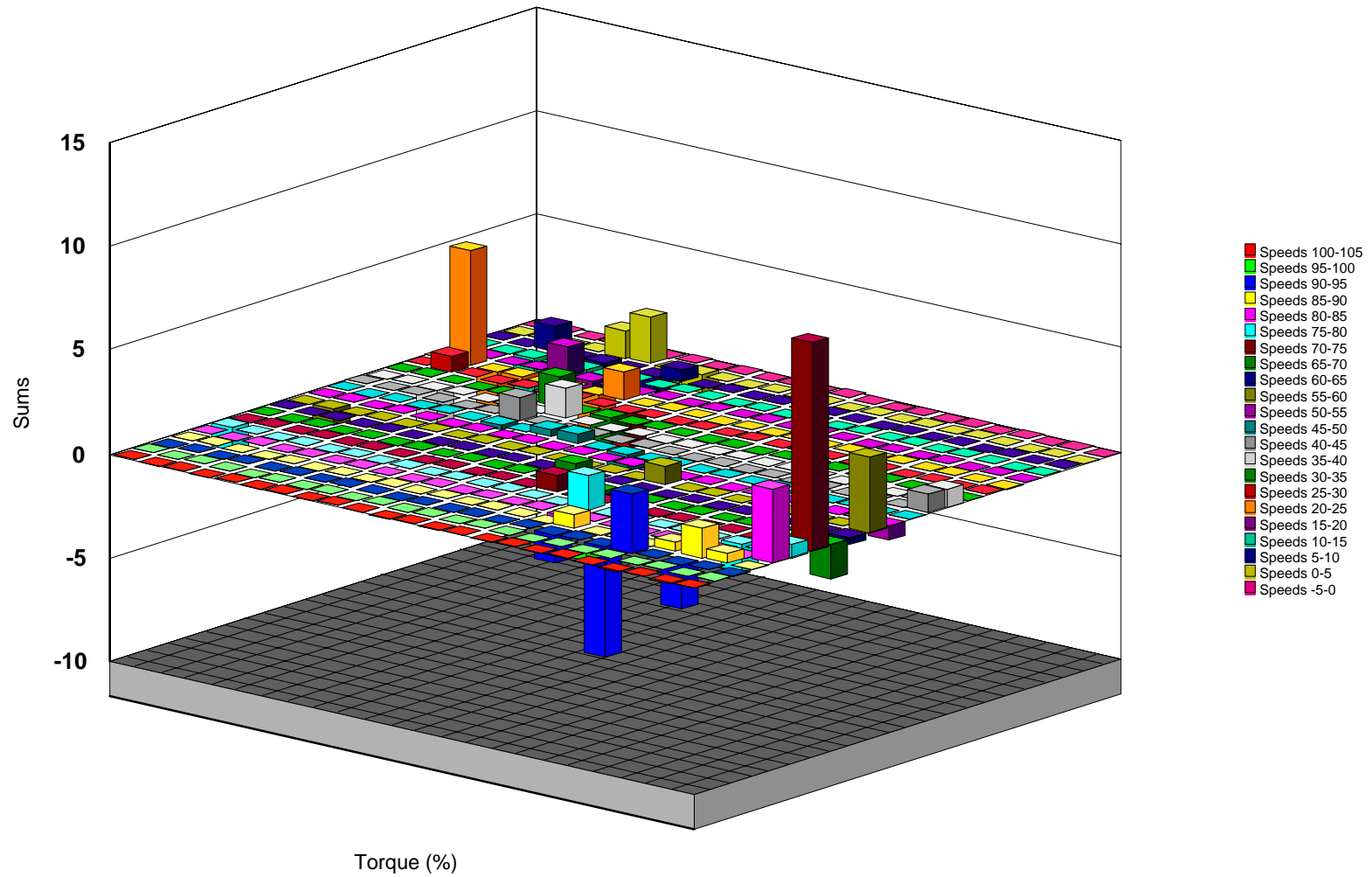
## WHEEL LOADER HIGH SPEED TRANSIENT--Torque Deceleration Standard Deviations



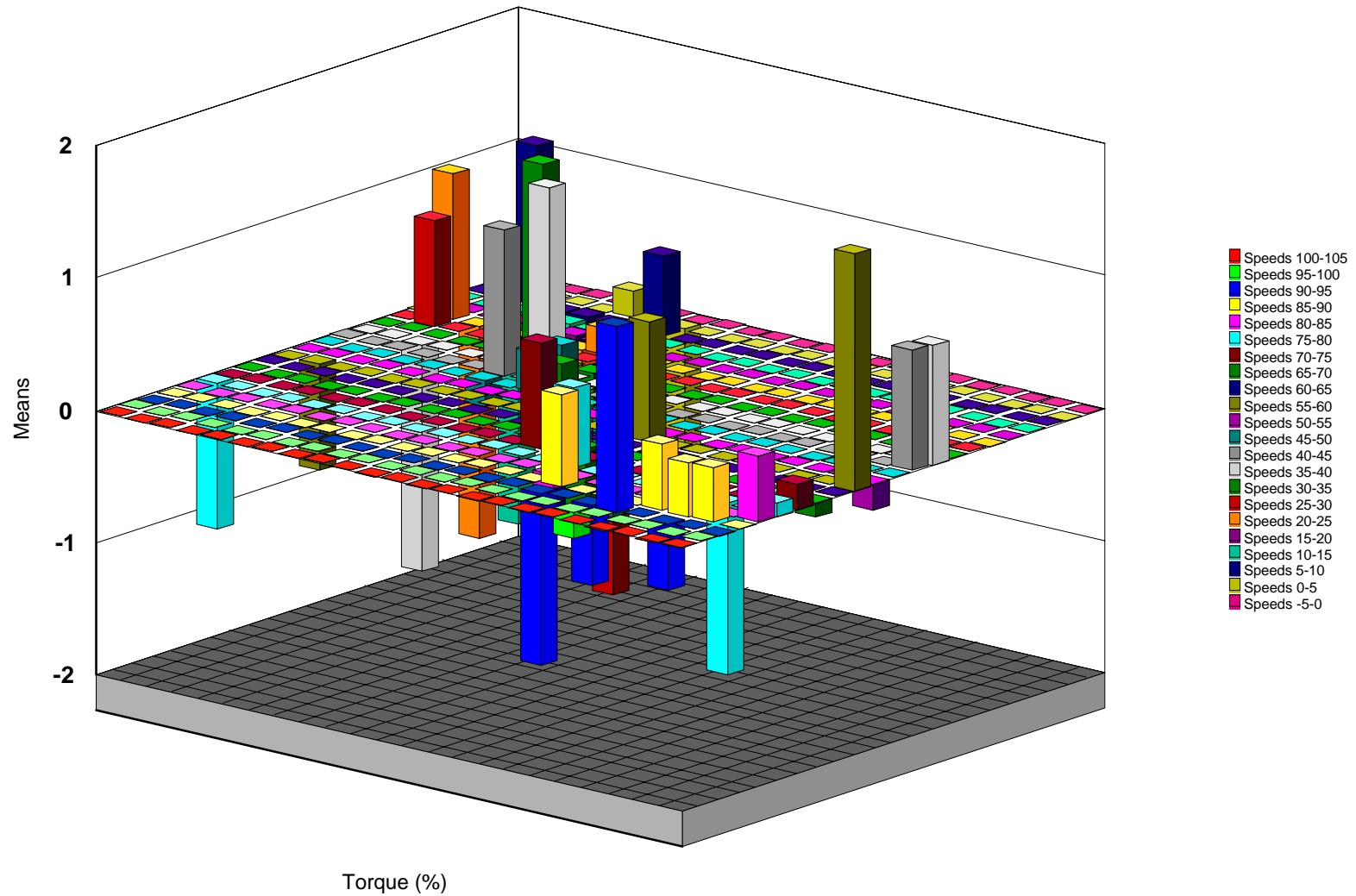
WHEEL LOADER HIGH SPEED TRANSIENT--Torque Steady State Counts



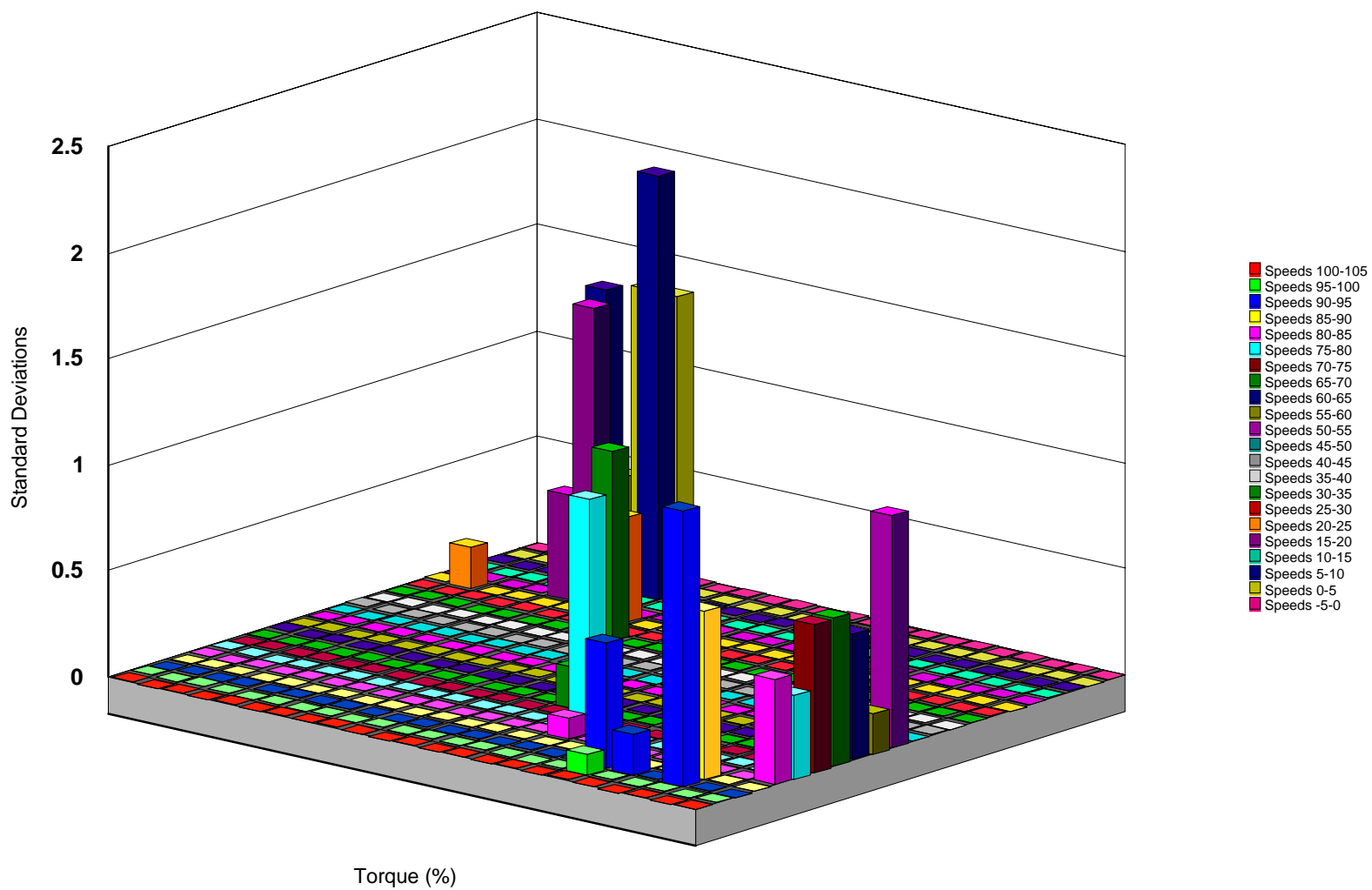
## WHEEL LOADER HIGH SPEED TRANSIENT--Torque Steady State



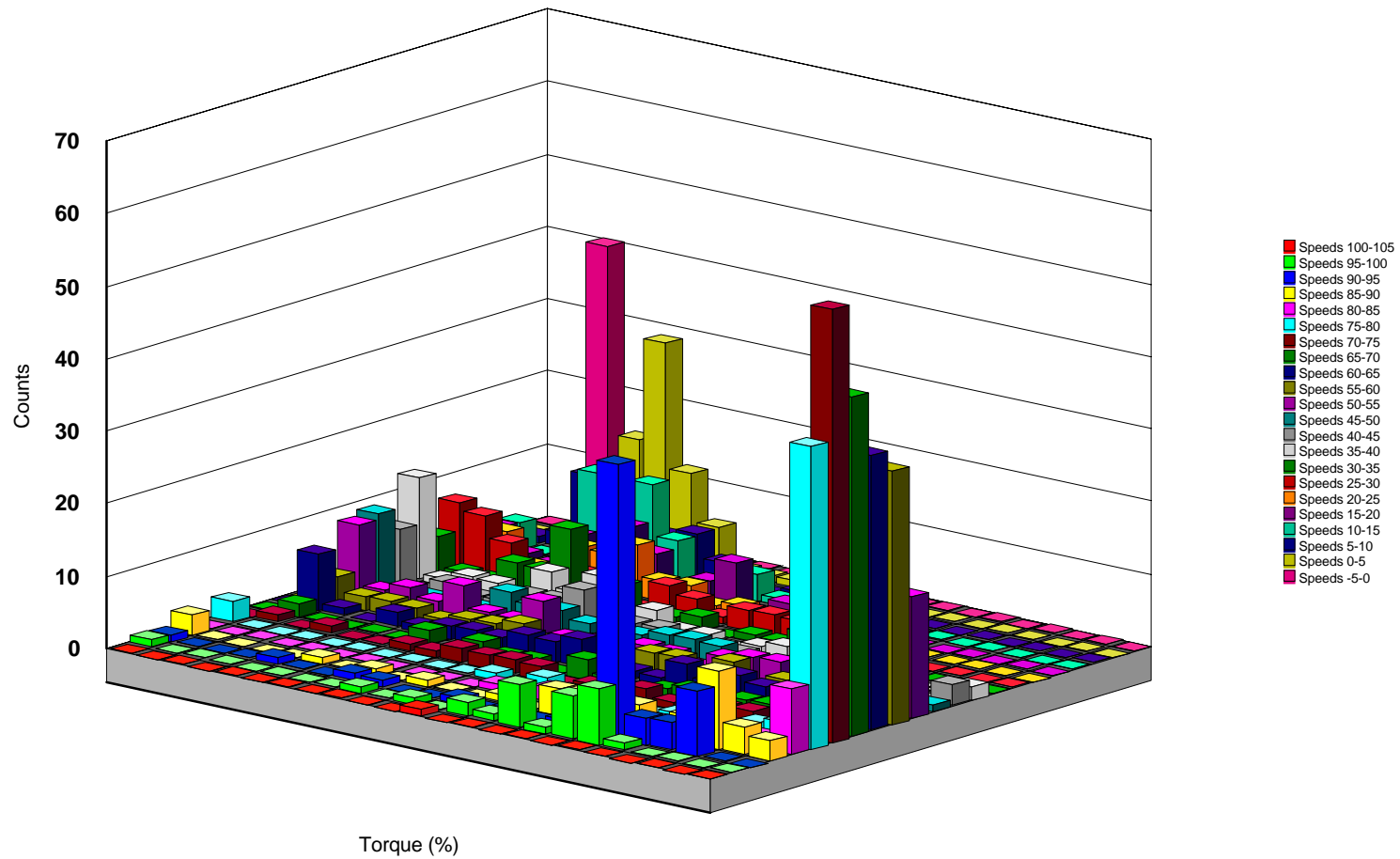
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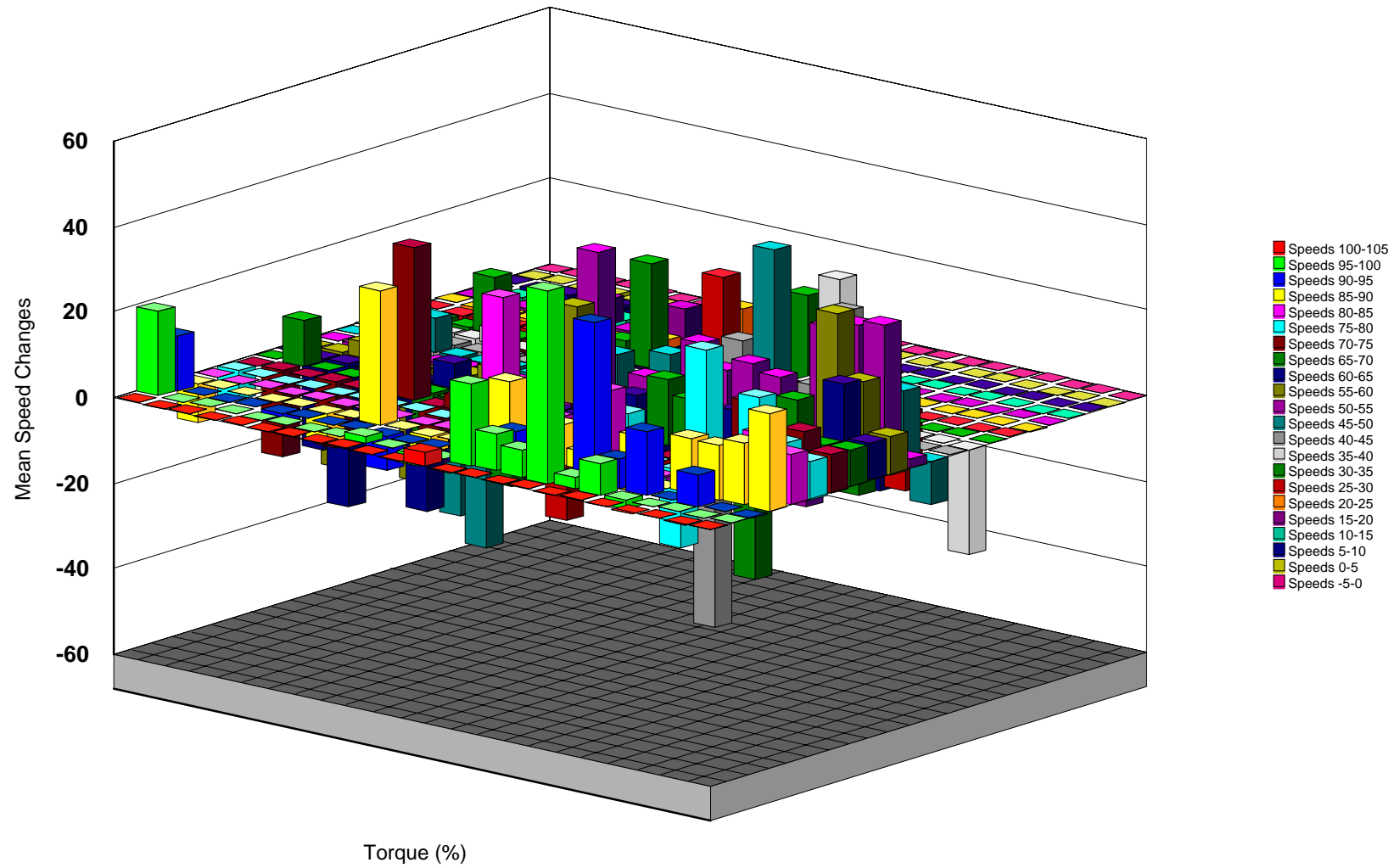
WHEEL LOADER HIGH SPEED TRANSIENT--Torque Steady State Standard Deviations



## WHEEL LOADER HIGH TORQUE TRANSIENT--Counts

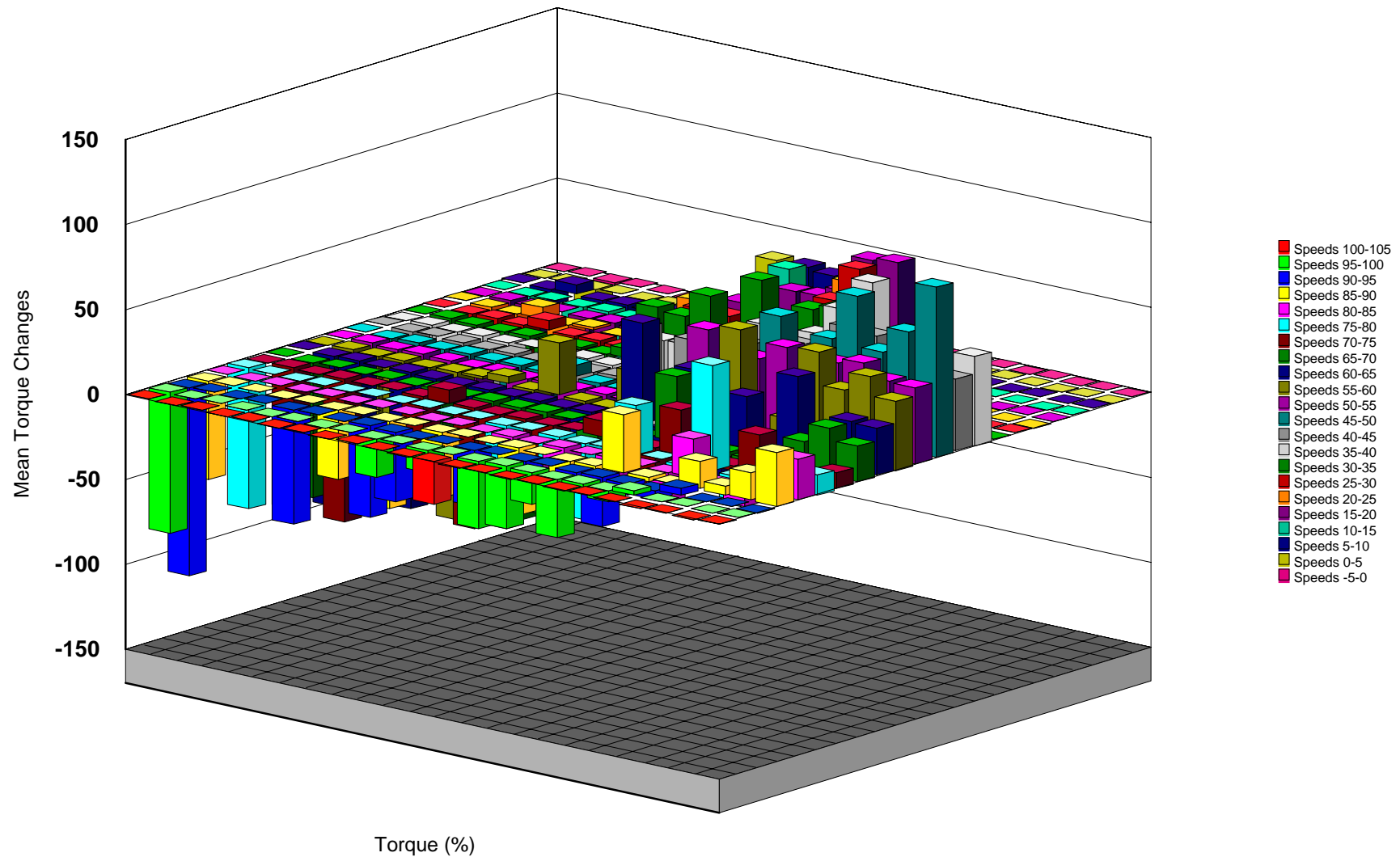


## WHEEL LOADER HIGH TORQUE TRANSIENT--Mean Speed Changes

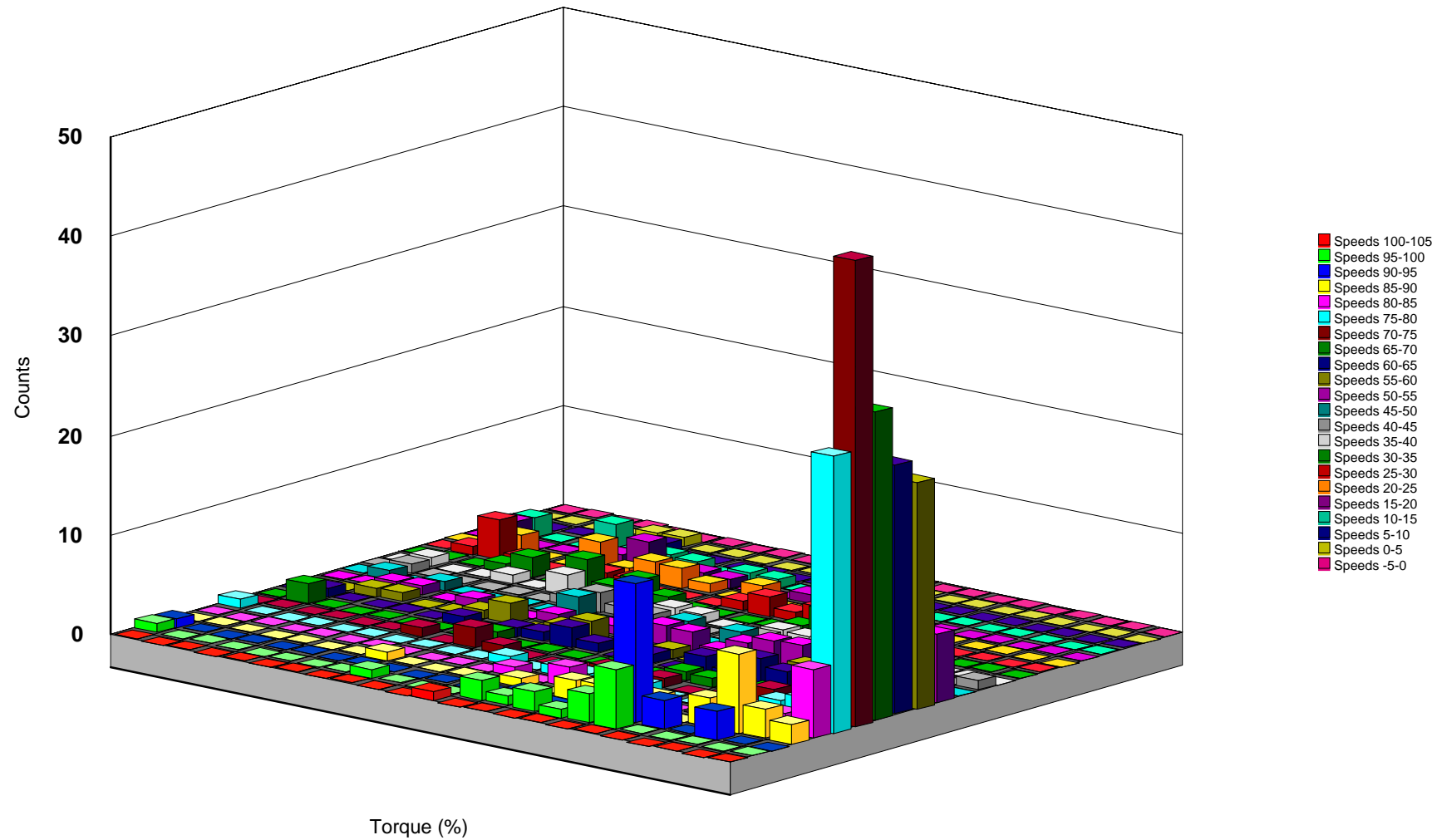




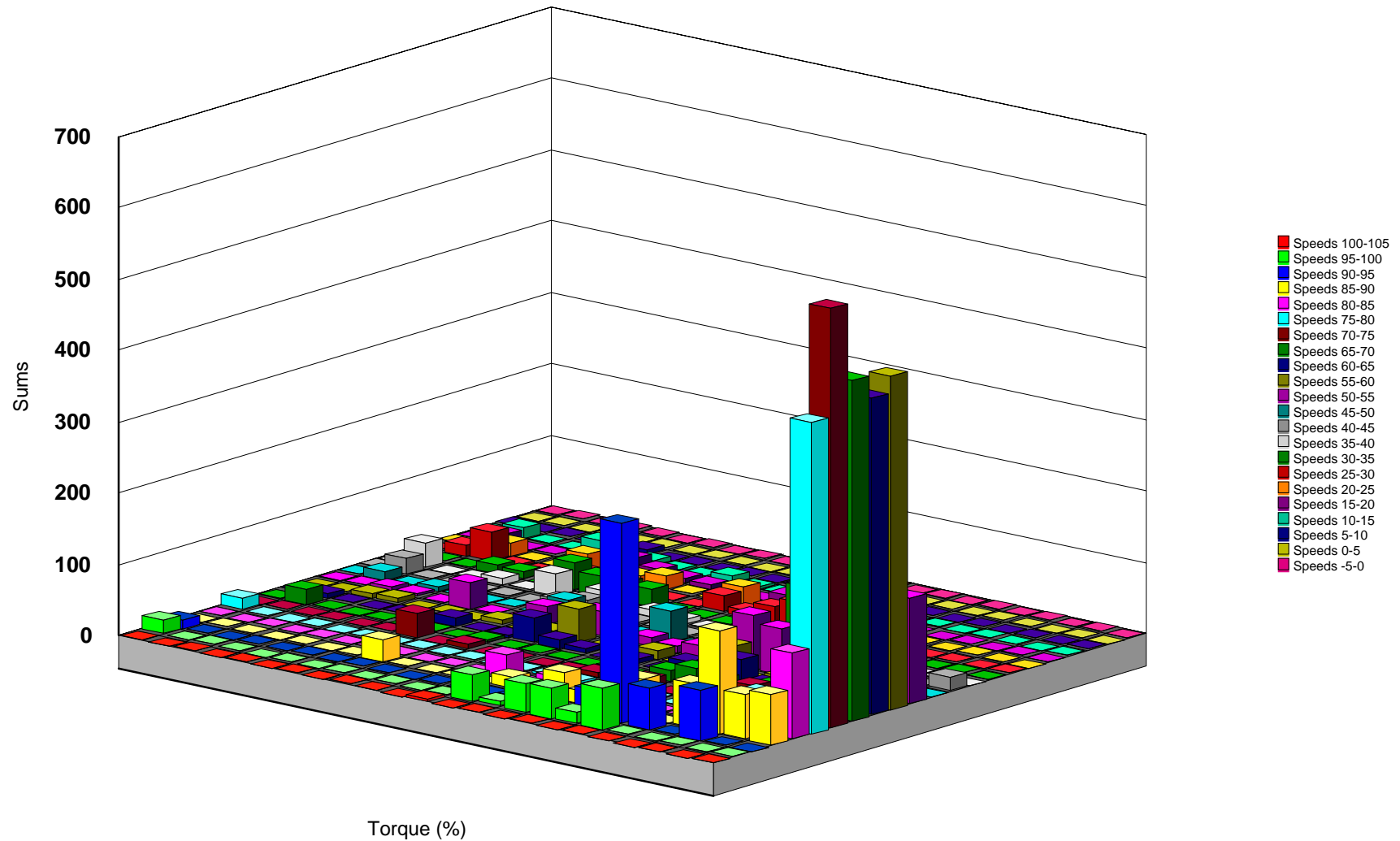
# WHEEL LOADER HIGH TORQUE TRANSIENT--Mean Torque Changes



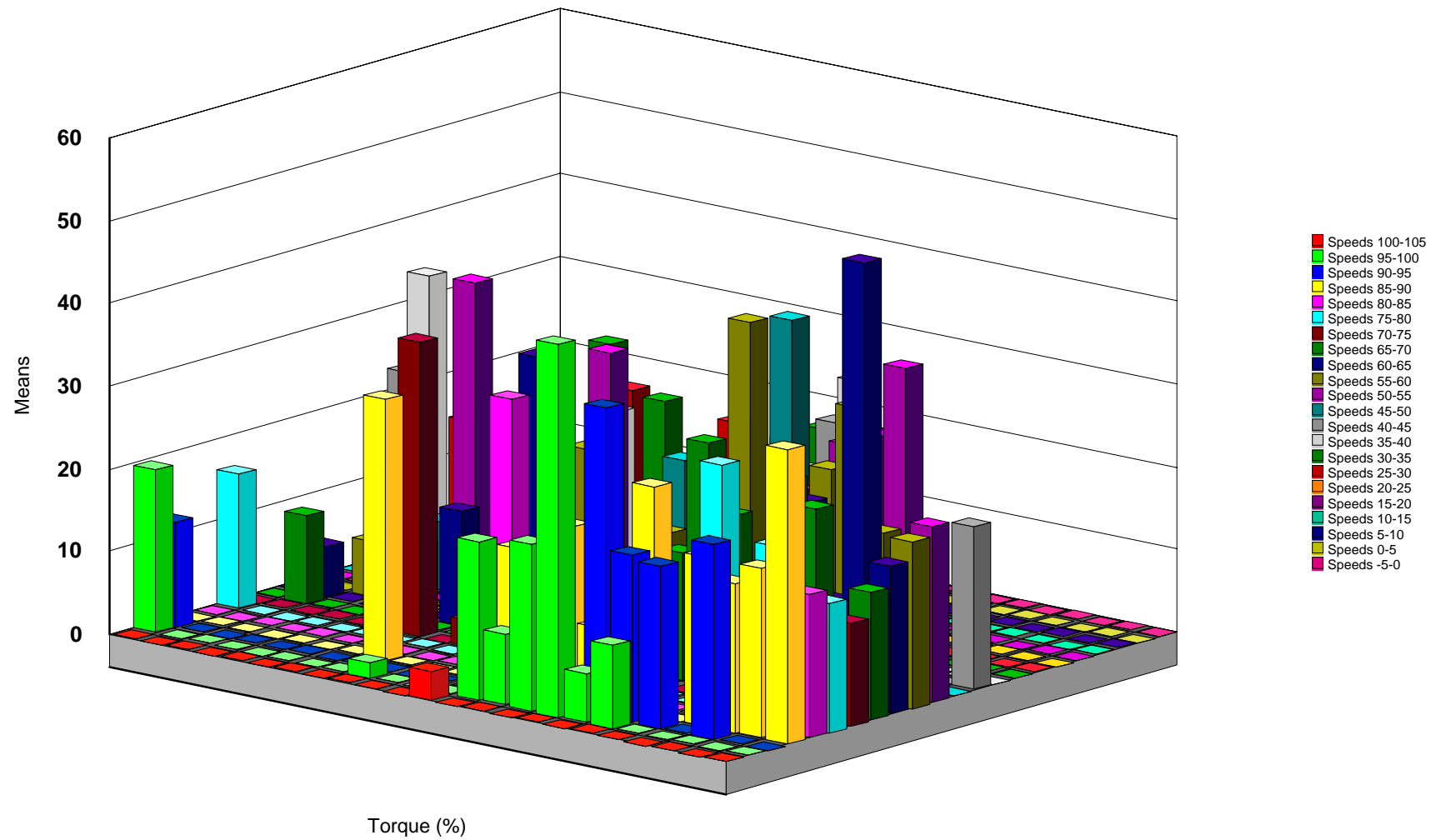
# WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Counts



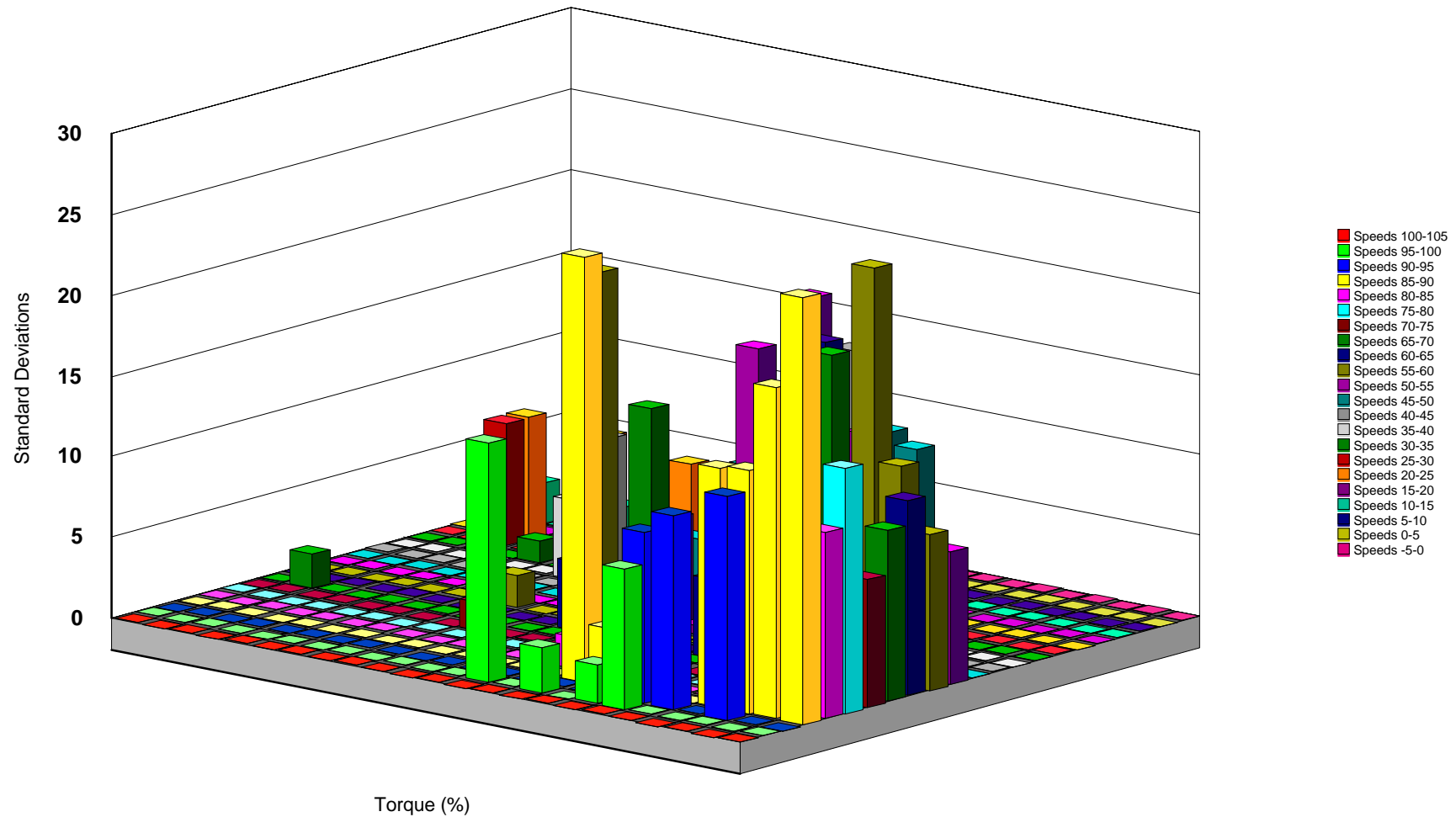
## WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Sums



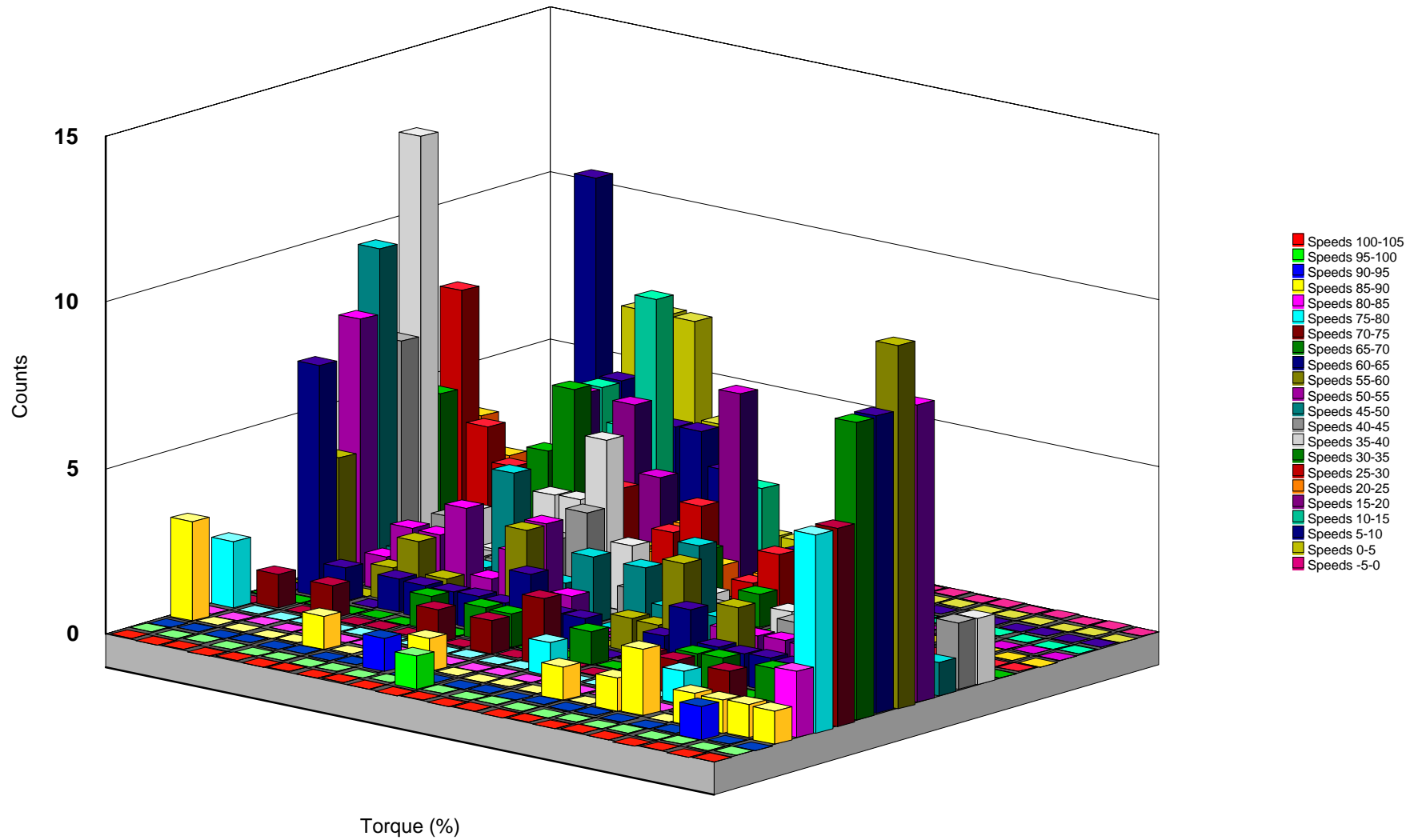
## WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Means



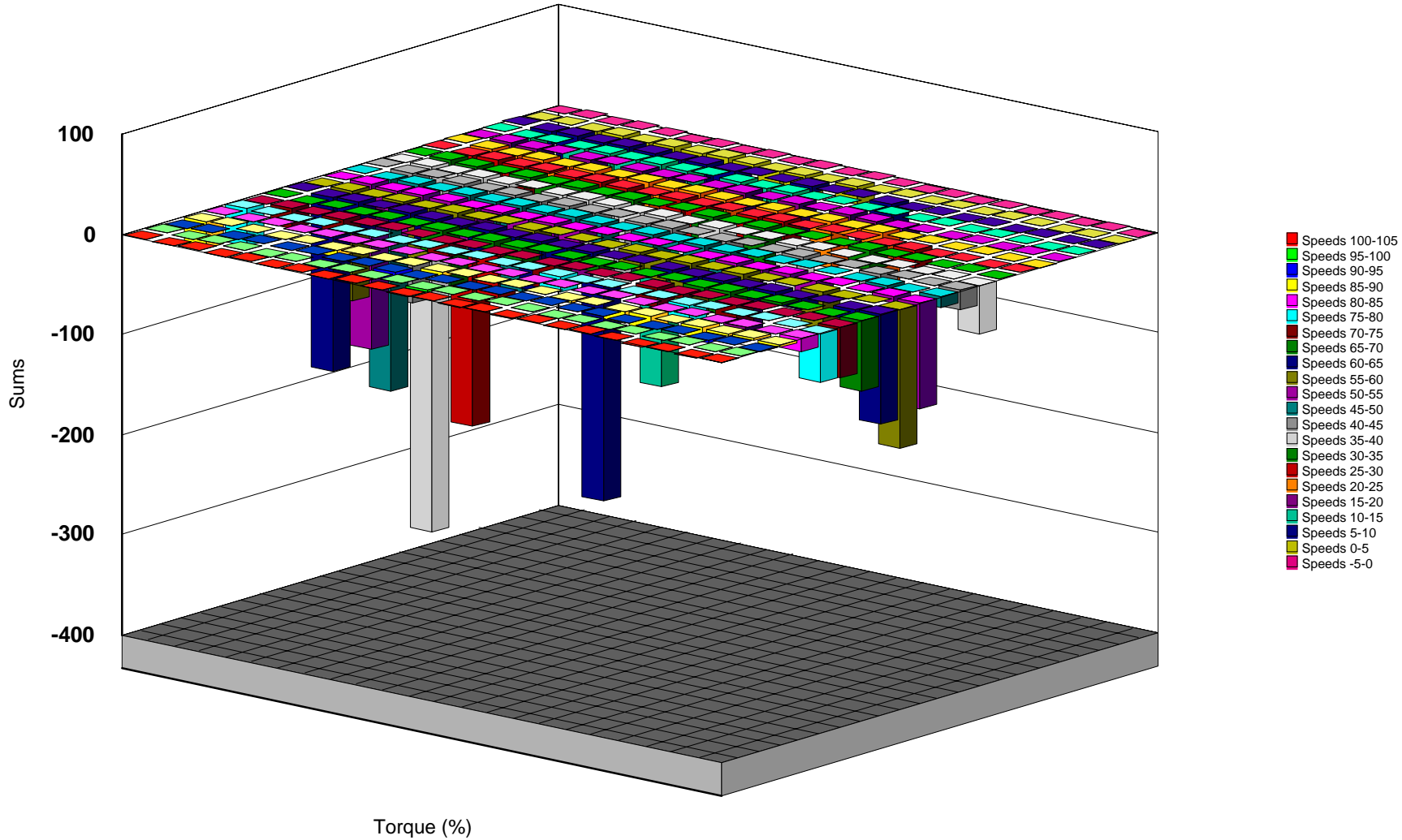
## WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Standard Deviations



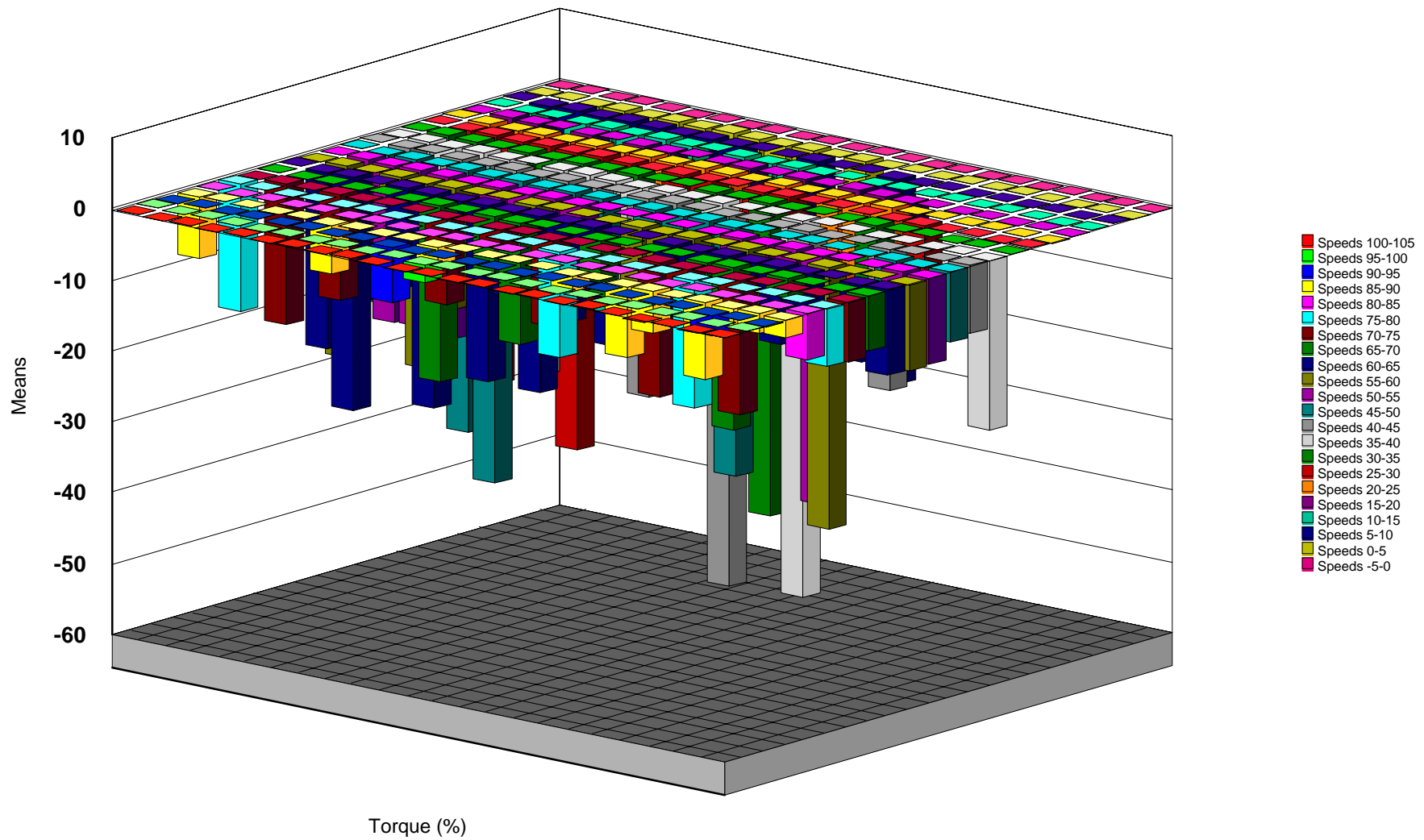
# WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Counts



# WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Sums

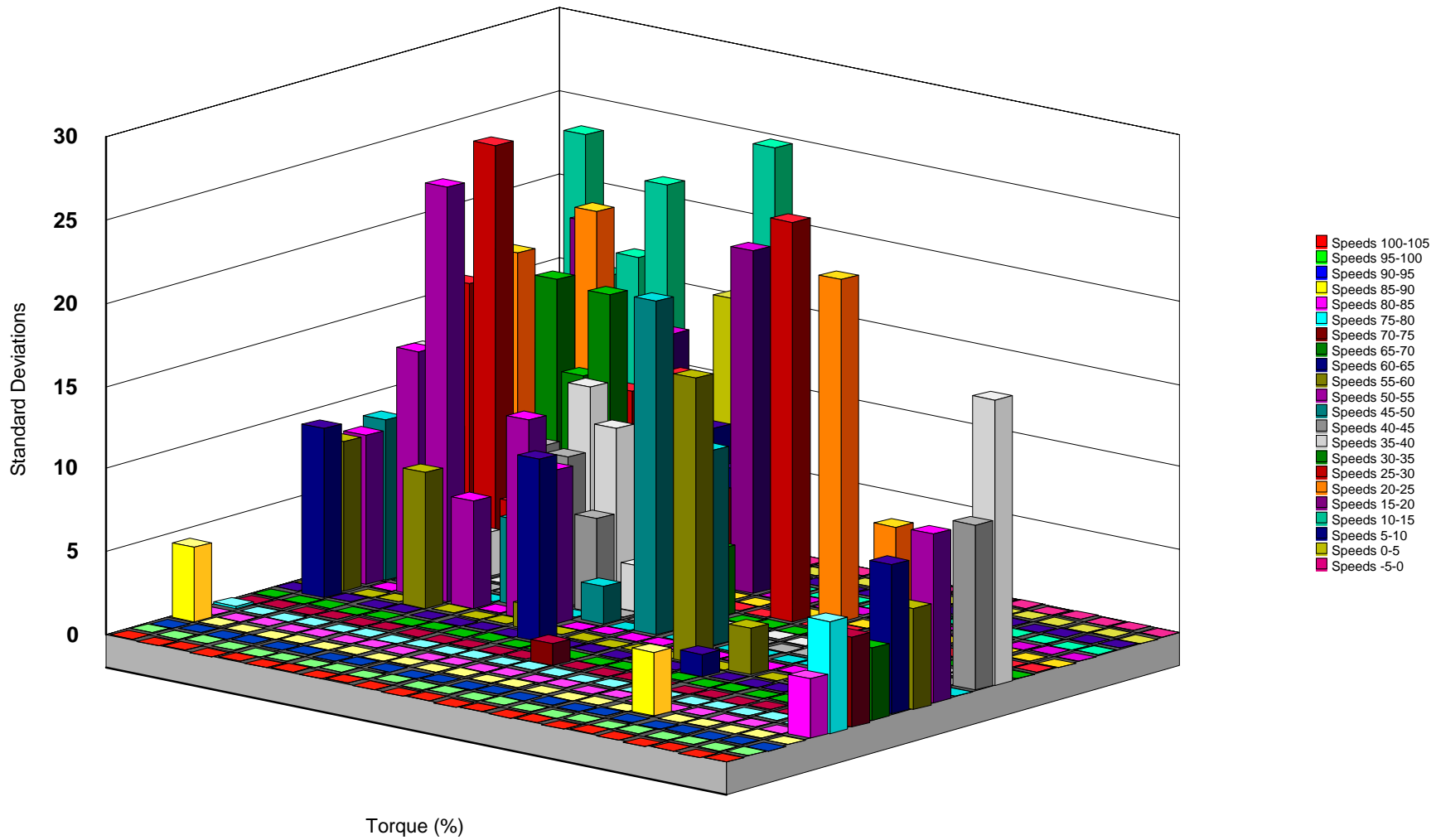


# WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Means

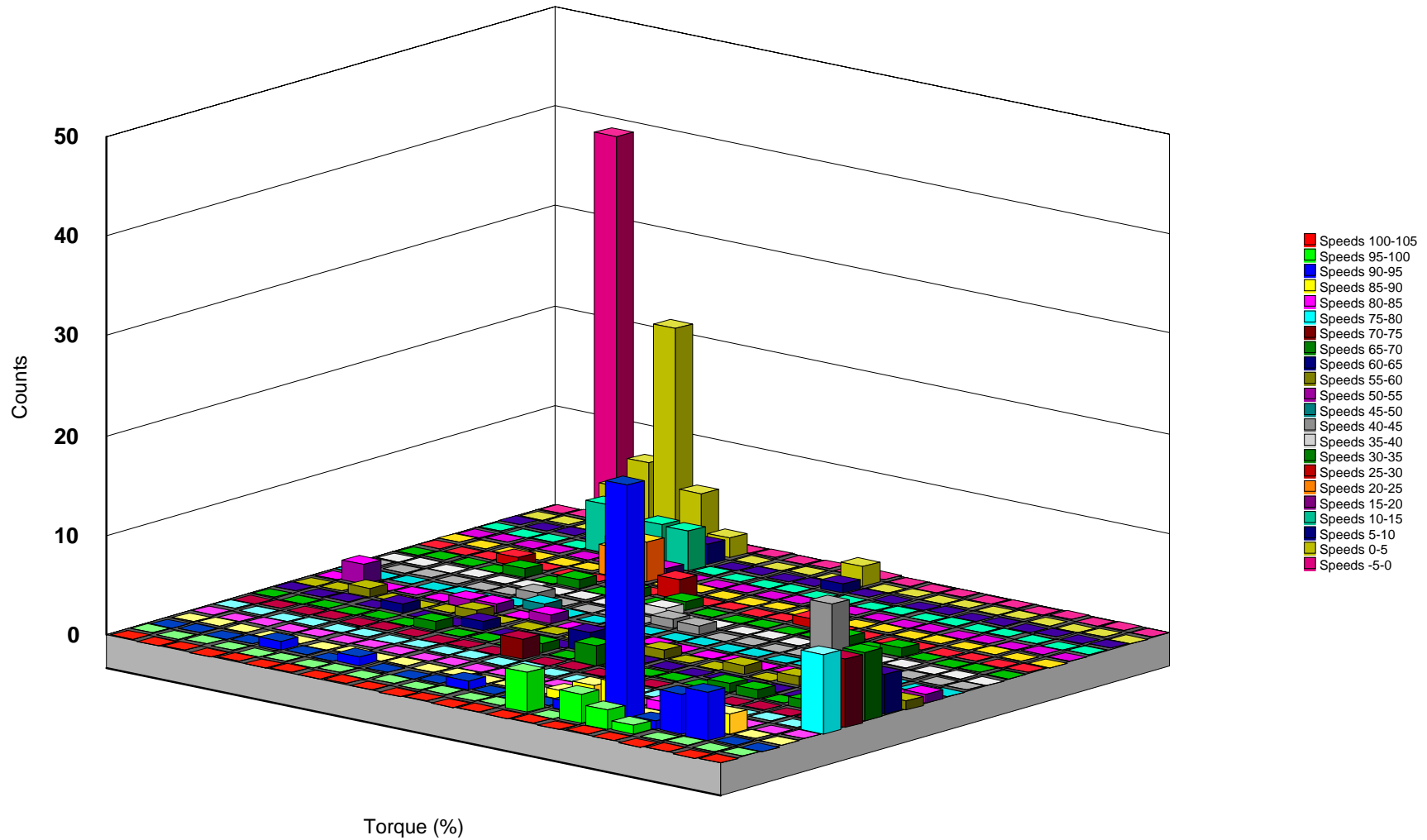




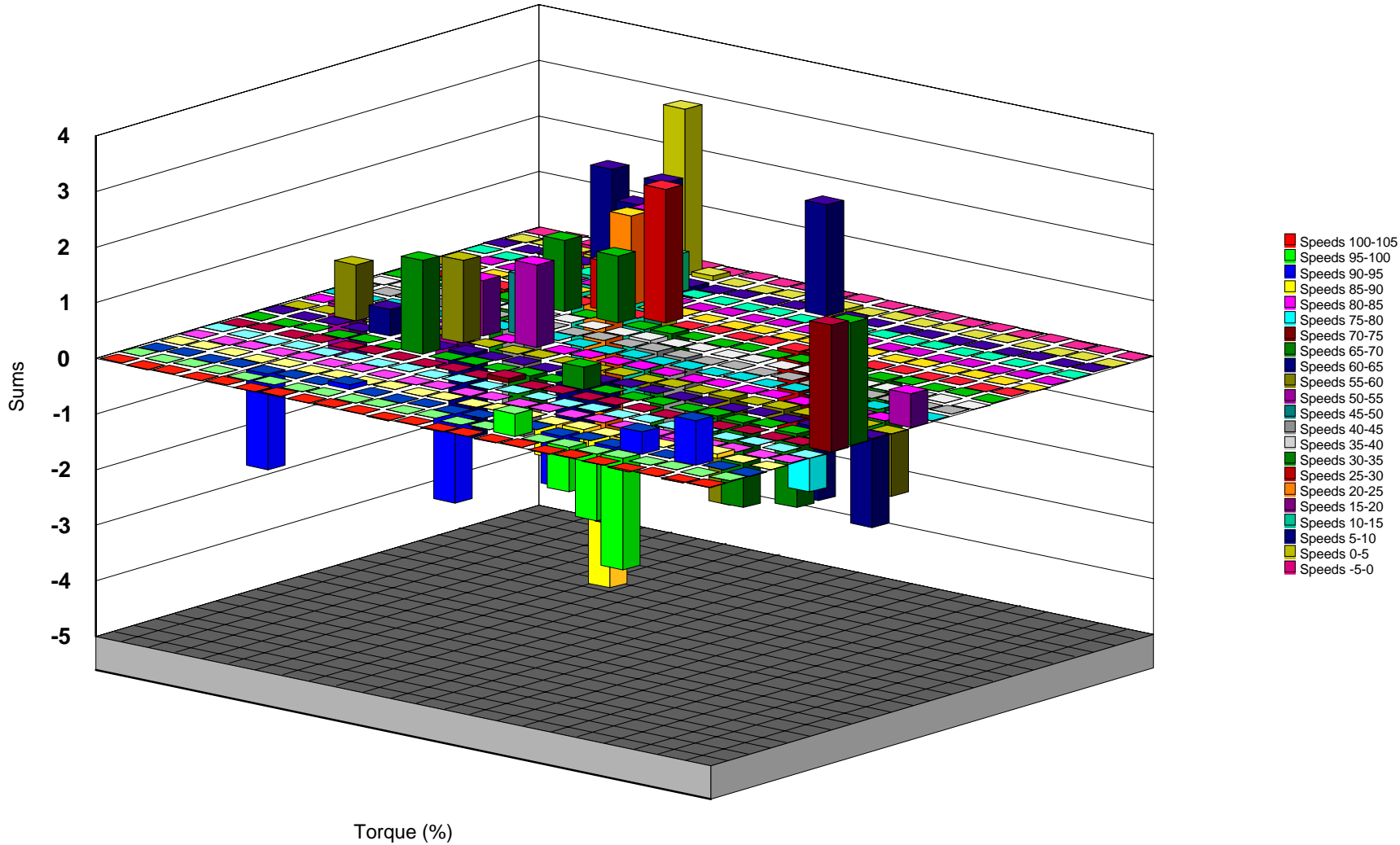
## WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Standard Deviations



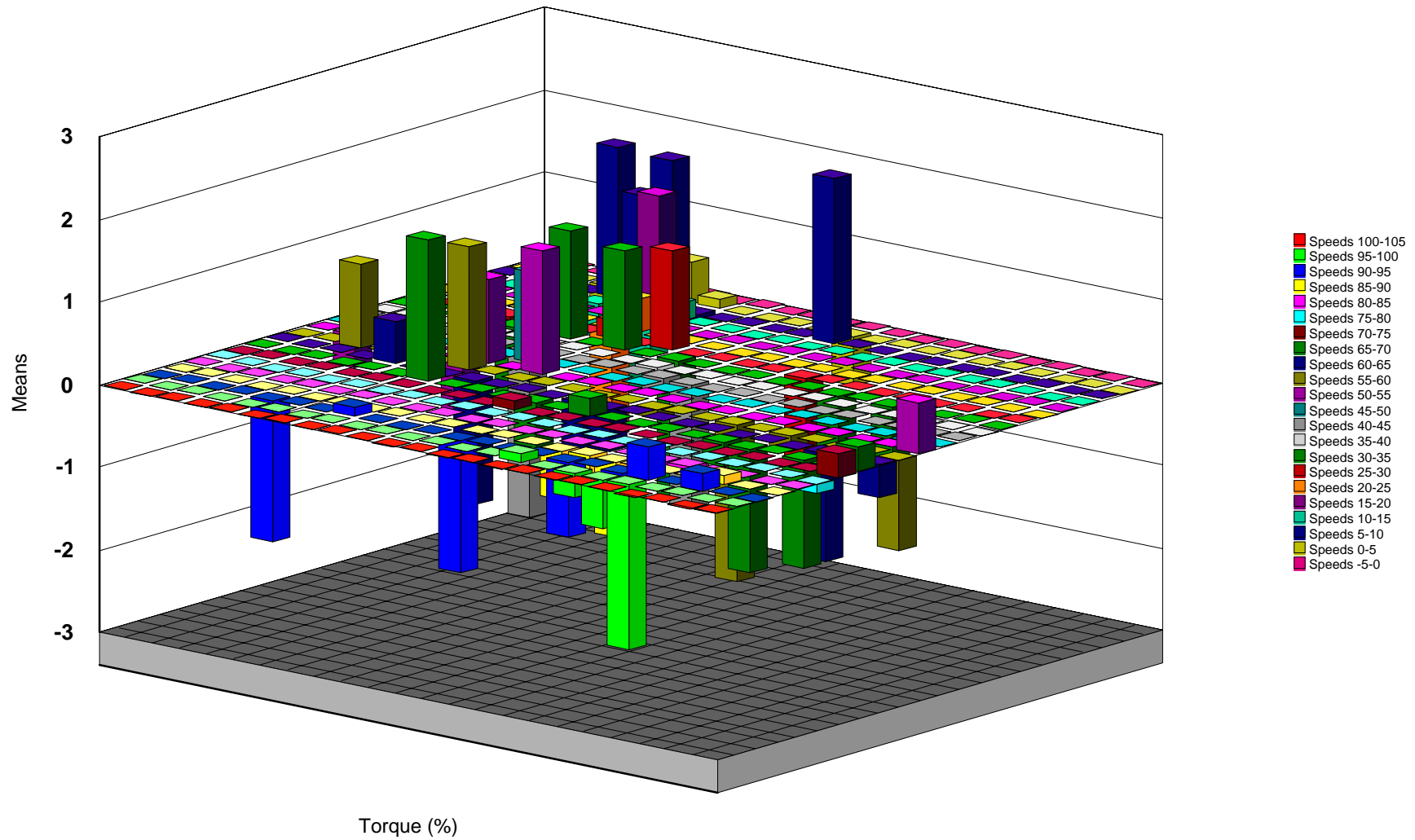
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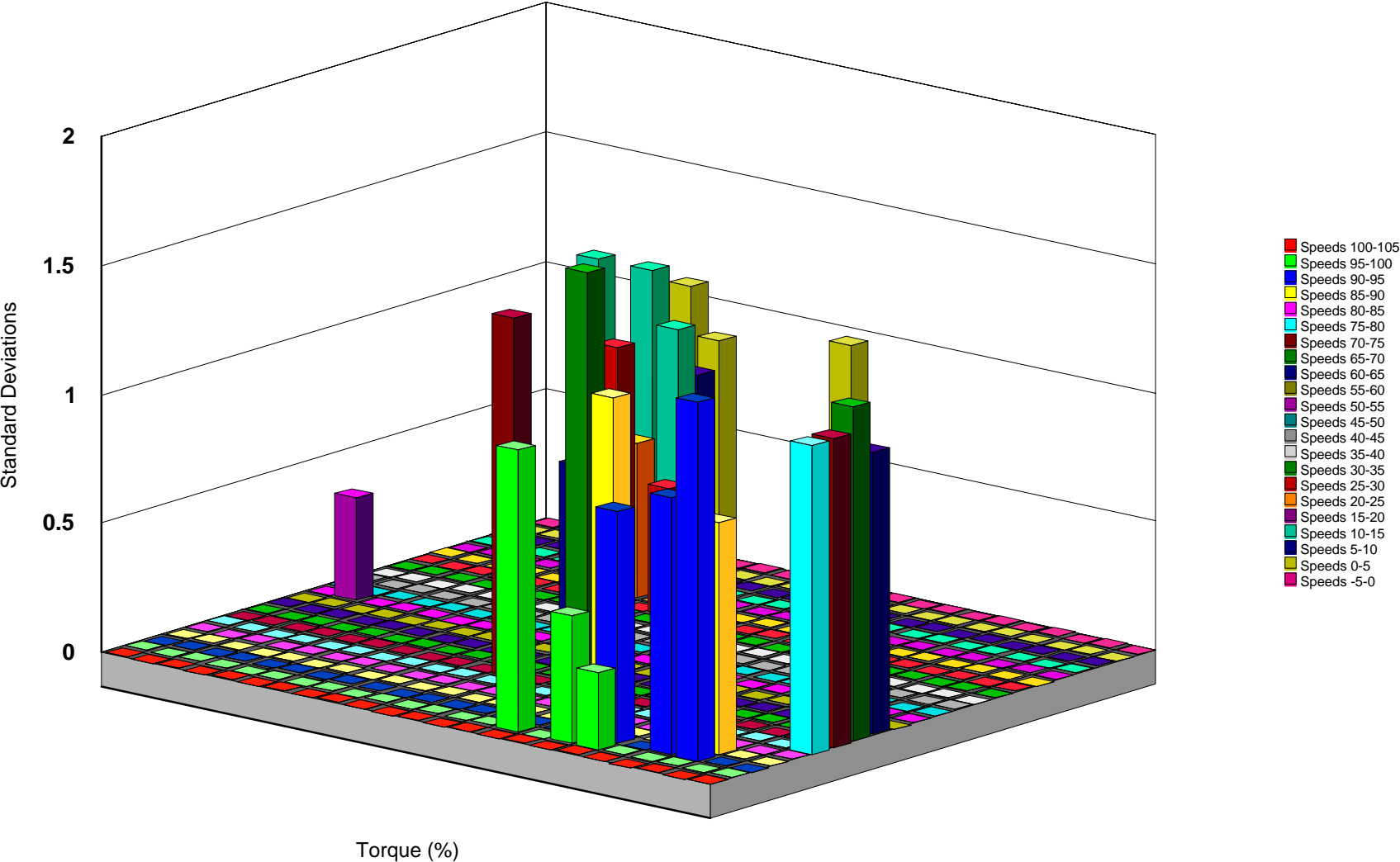
# WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Steady State Sums



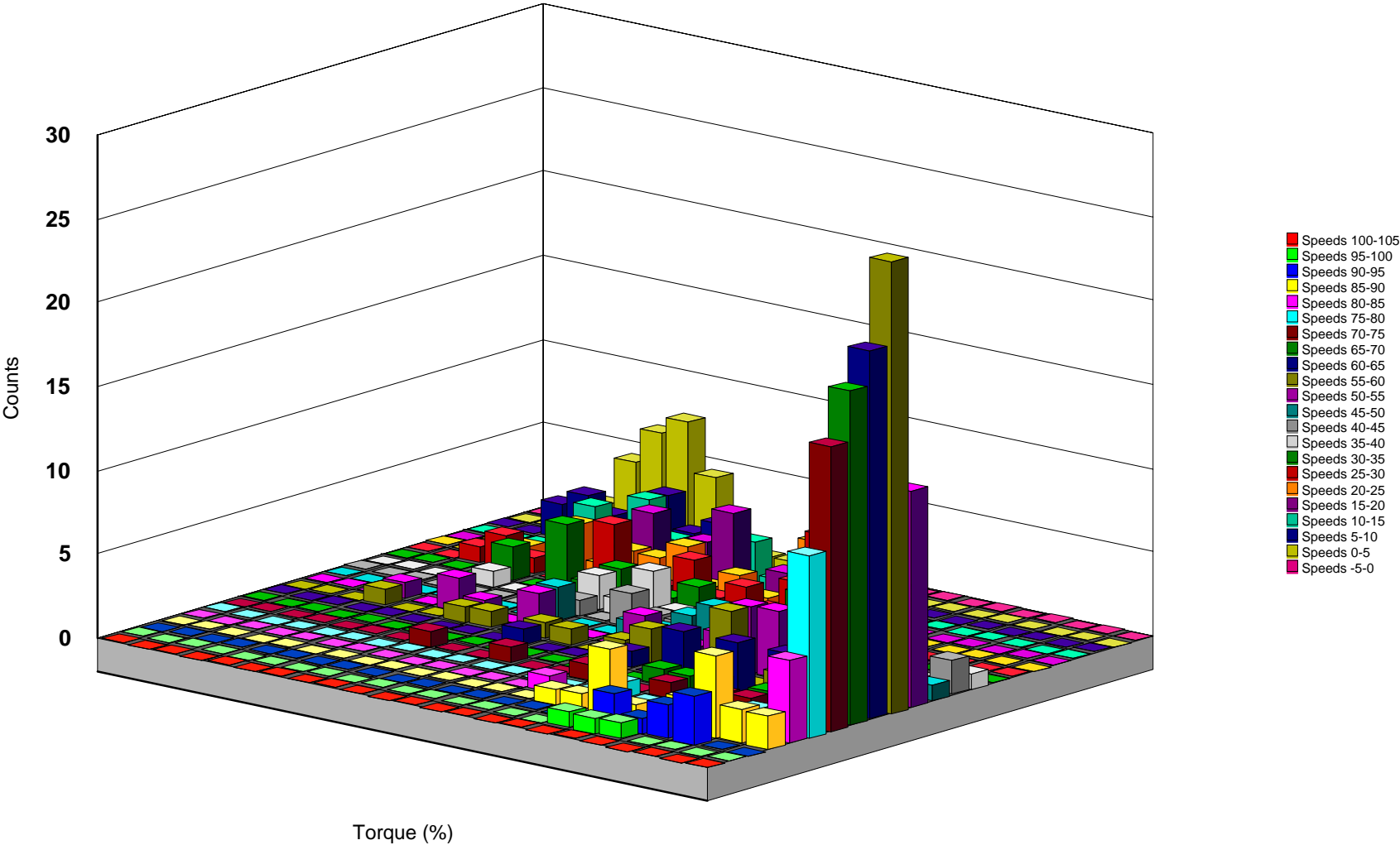
# WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Steady State Means



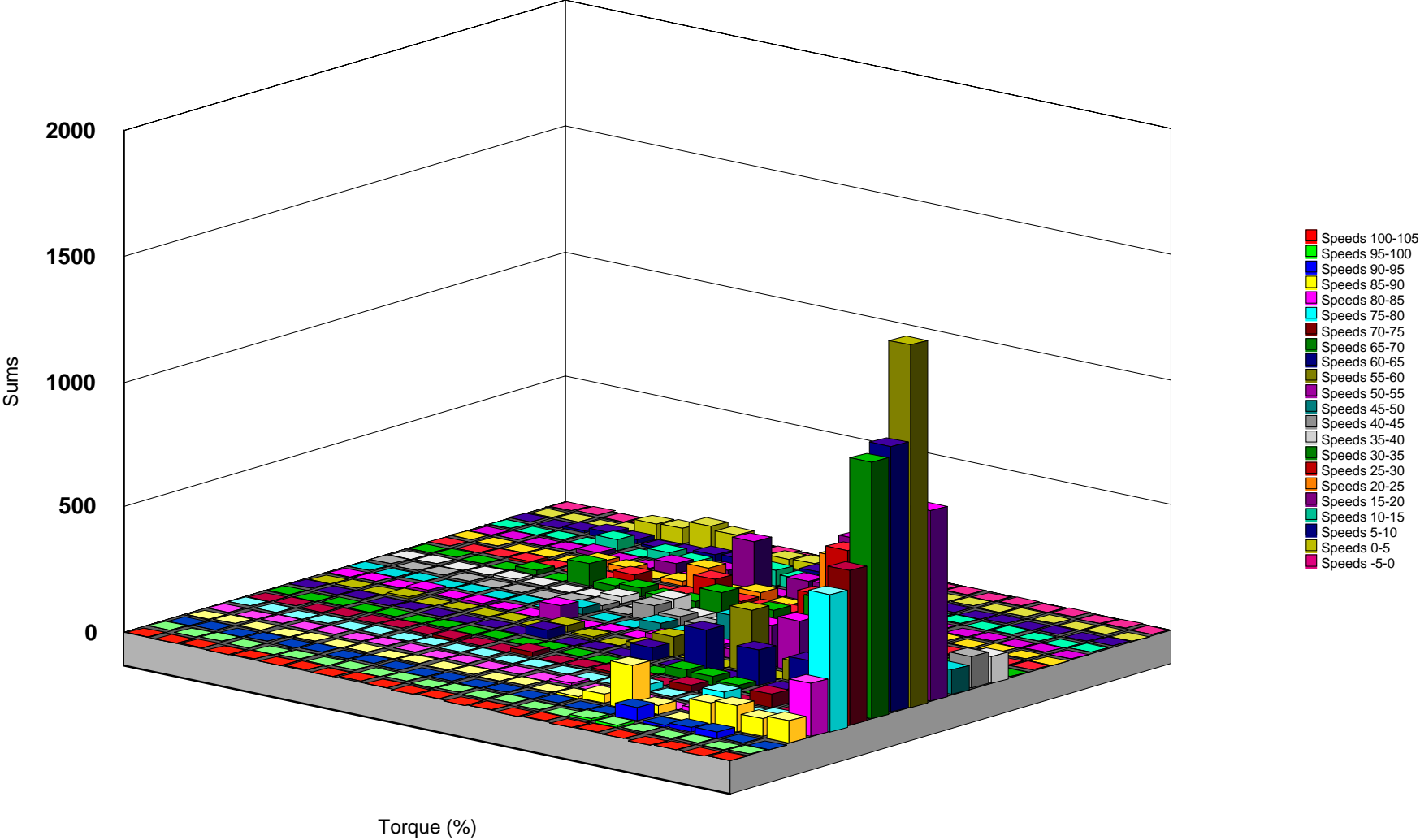
WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Steady State Standard Deviations



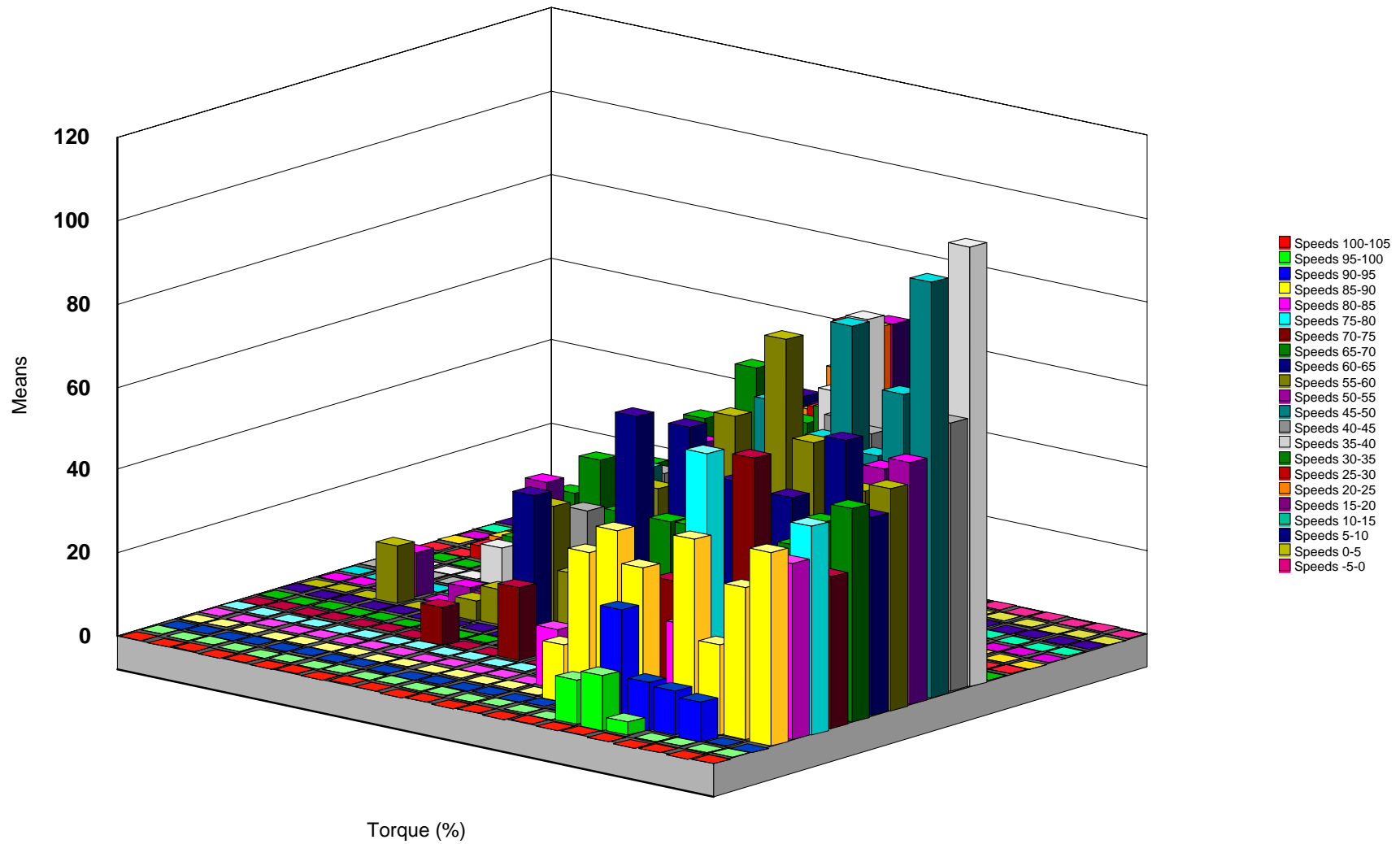
# WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Acceleration Counts



# WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Acceleration Sums

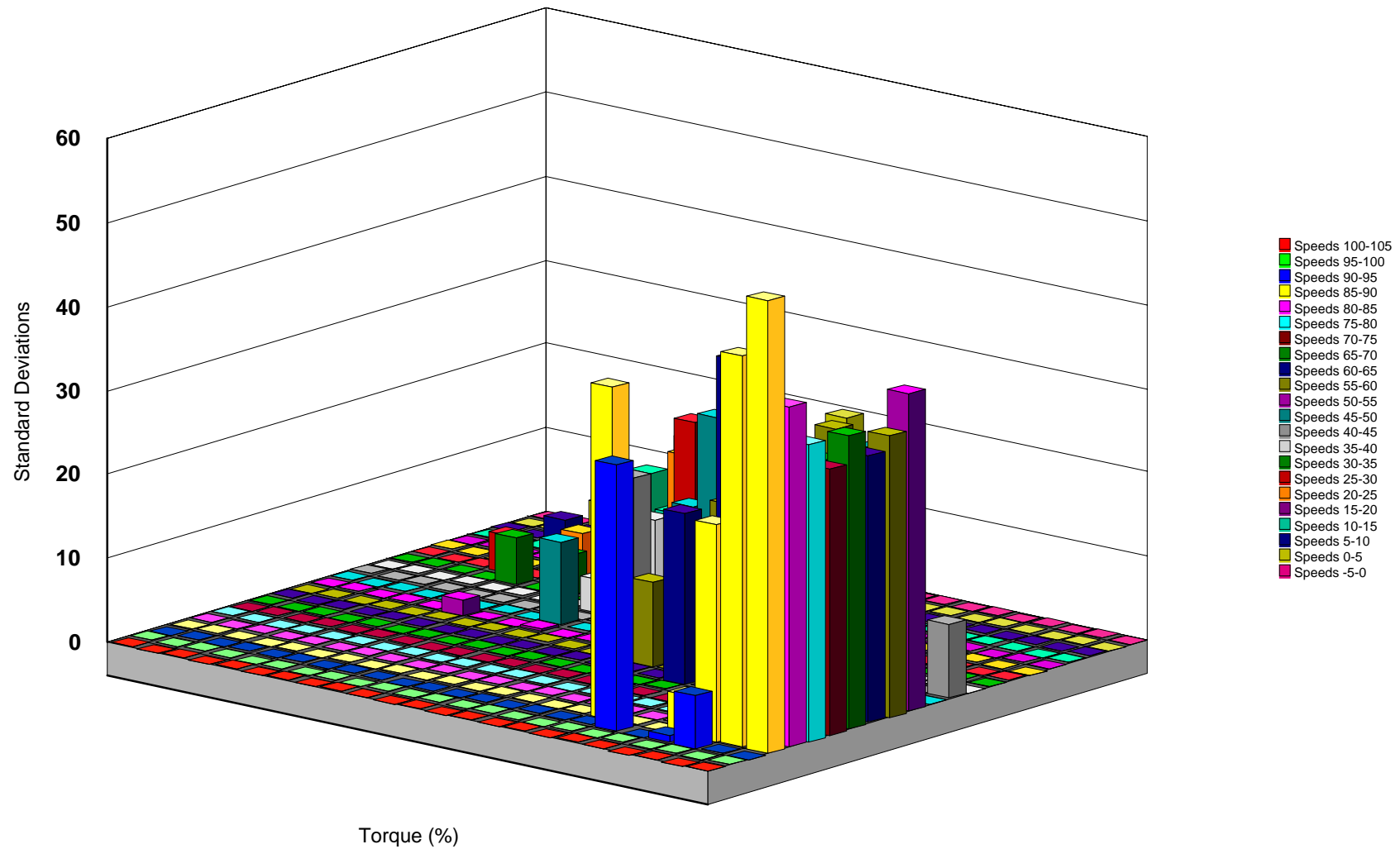


## WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Acceleration Means

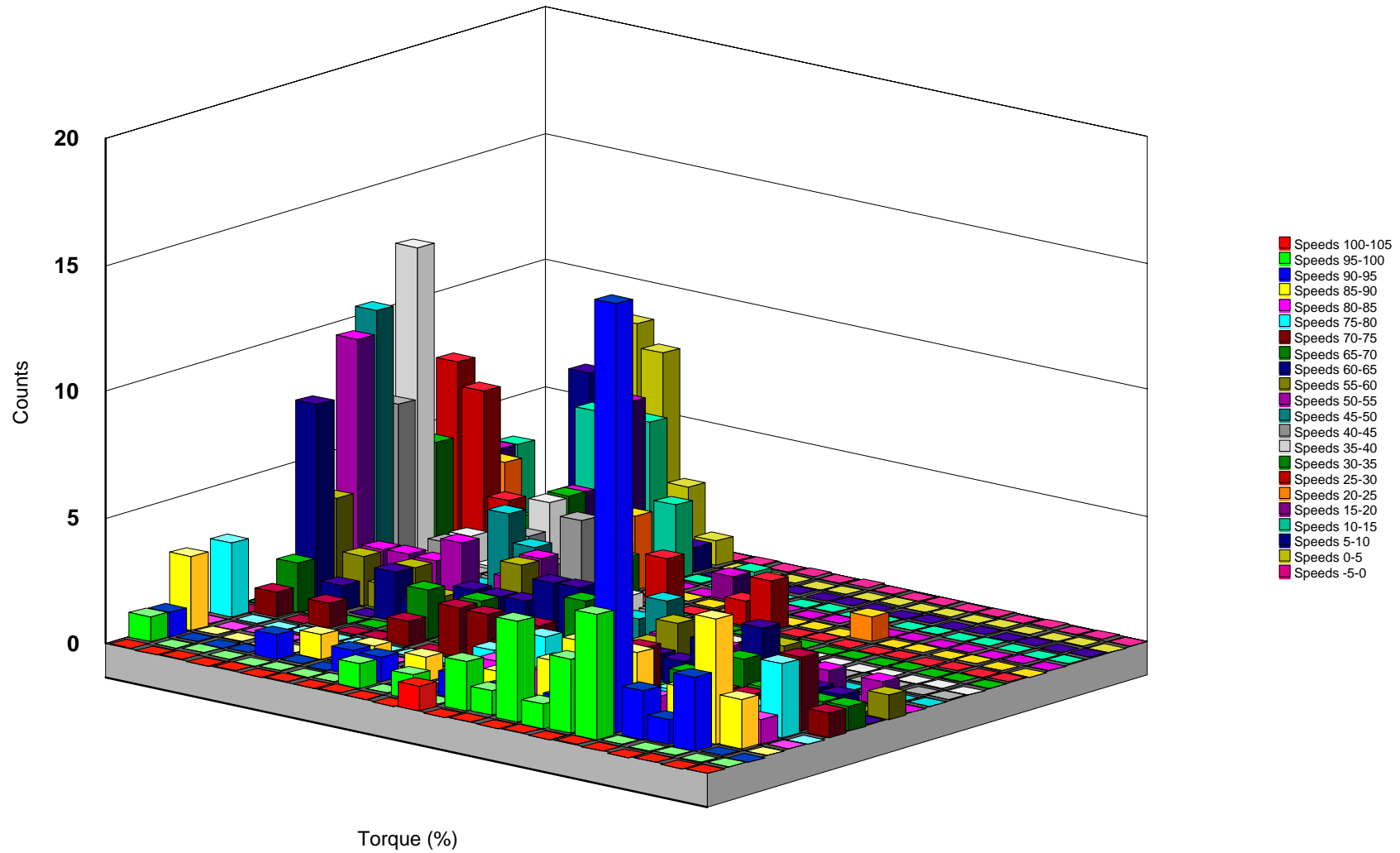




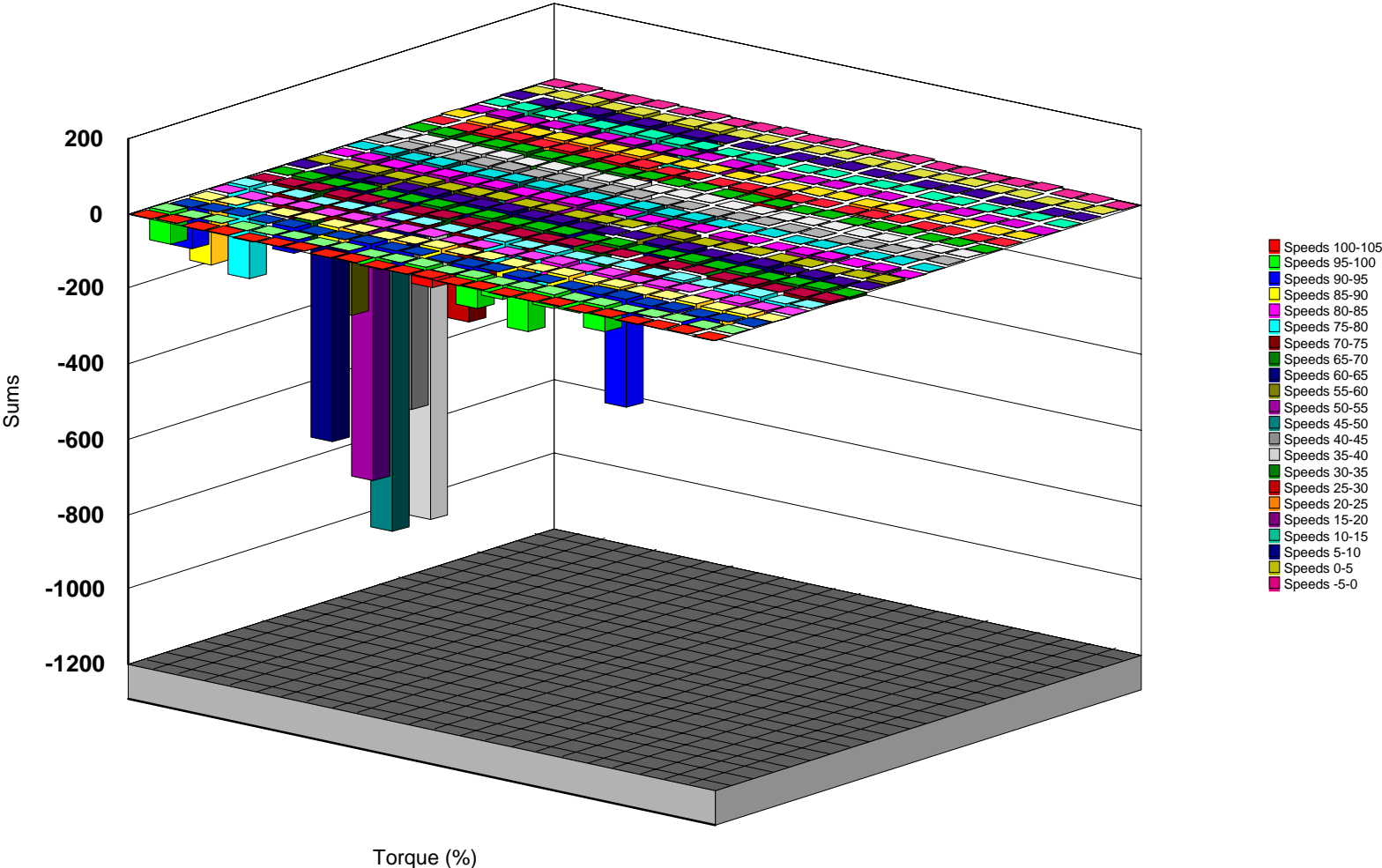
## WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Acceleration Standard Deviations



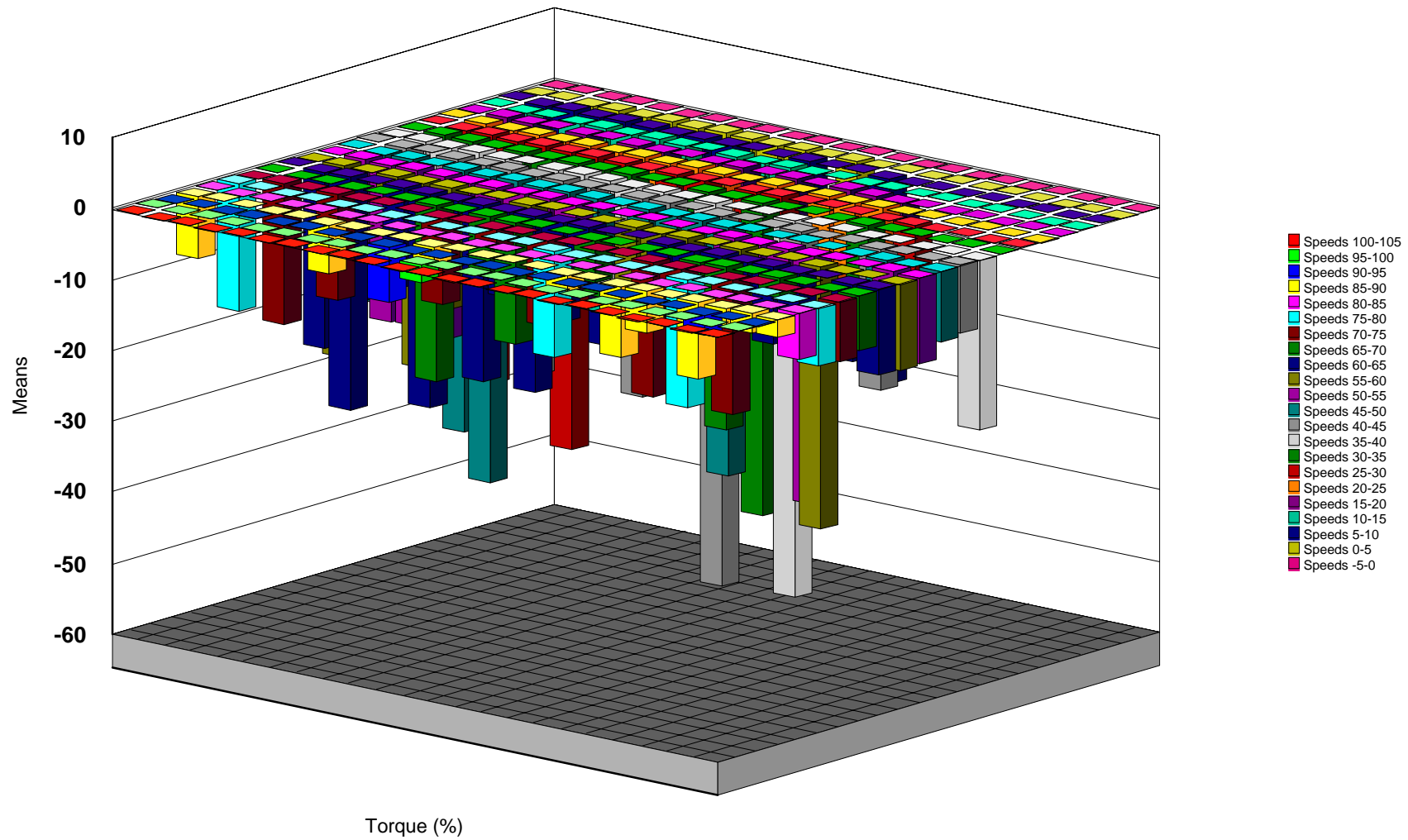
## WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Deceleration Counts



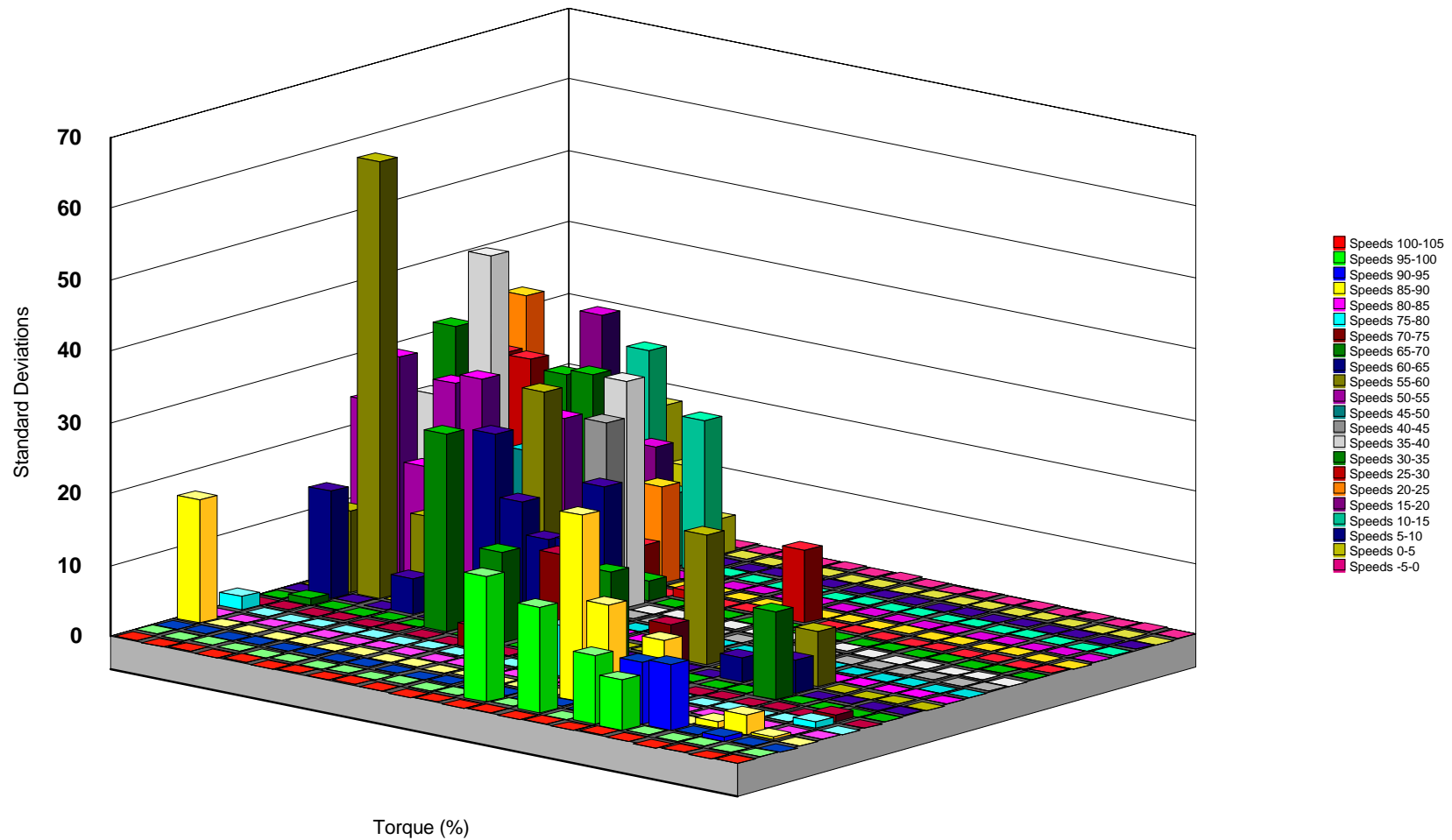
# WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Deceleration Sur



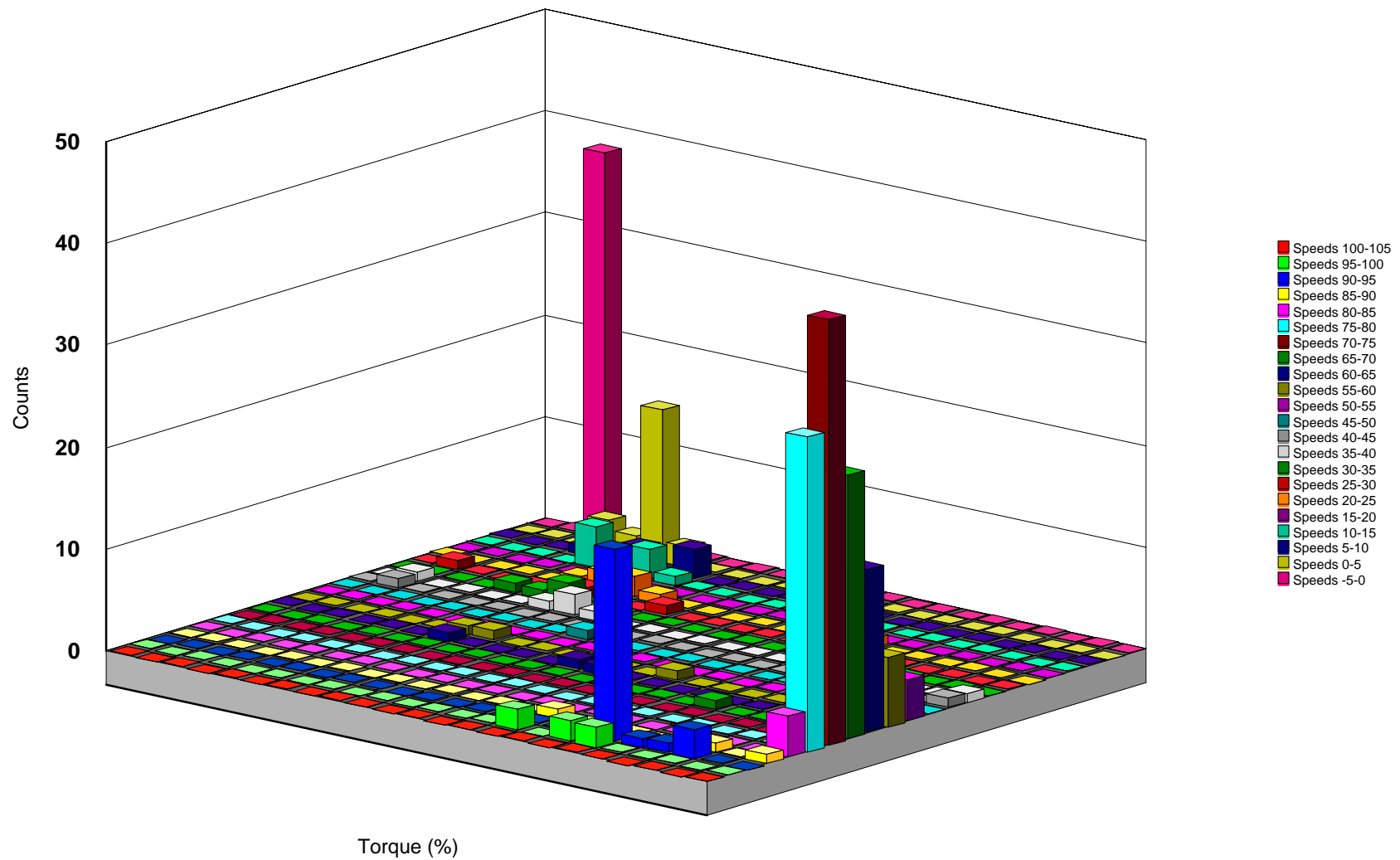
## WHEEL LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Means



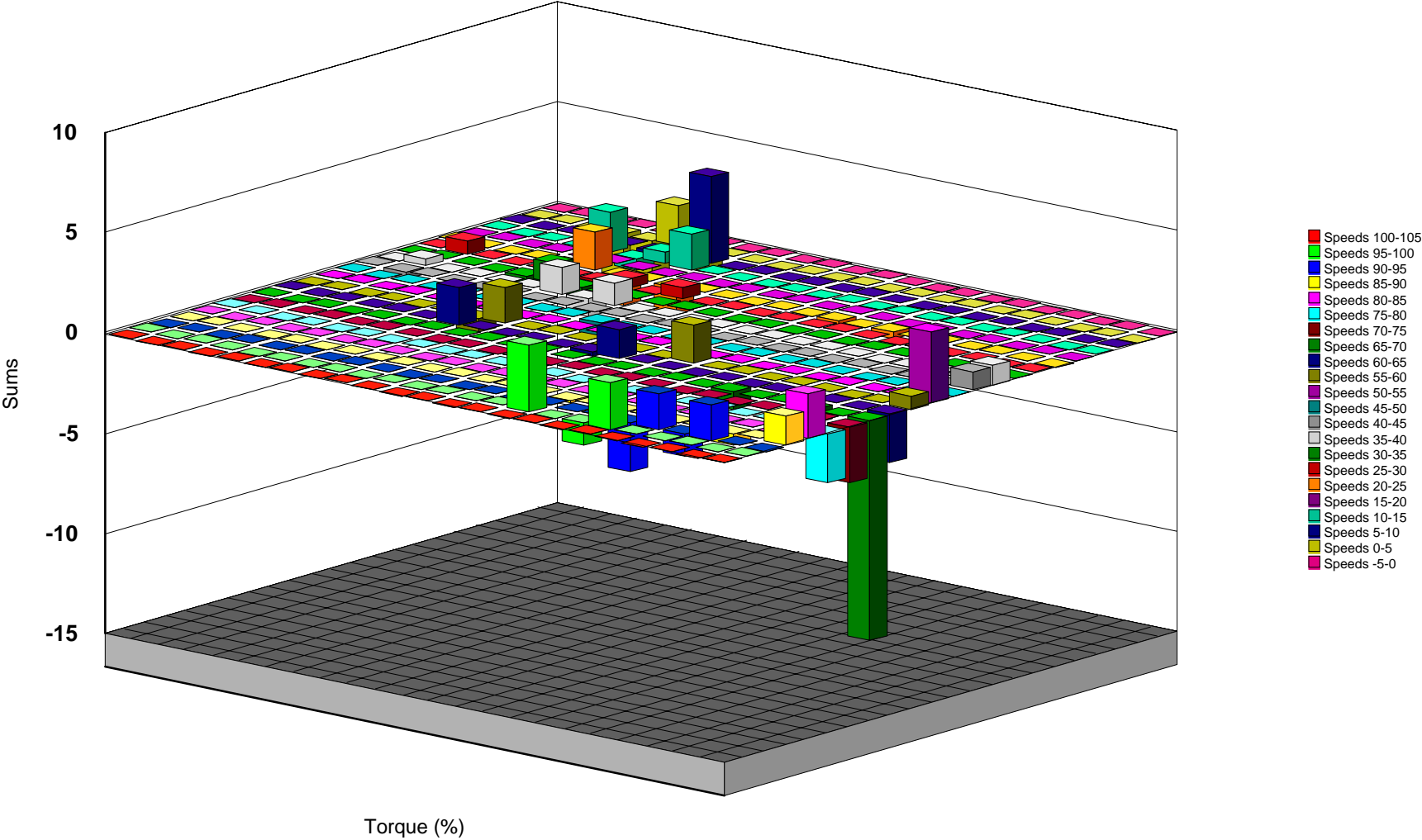
## WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Deceleration Standard Deviations



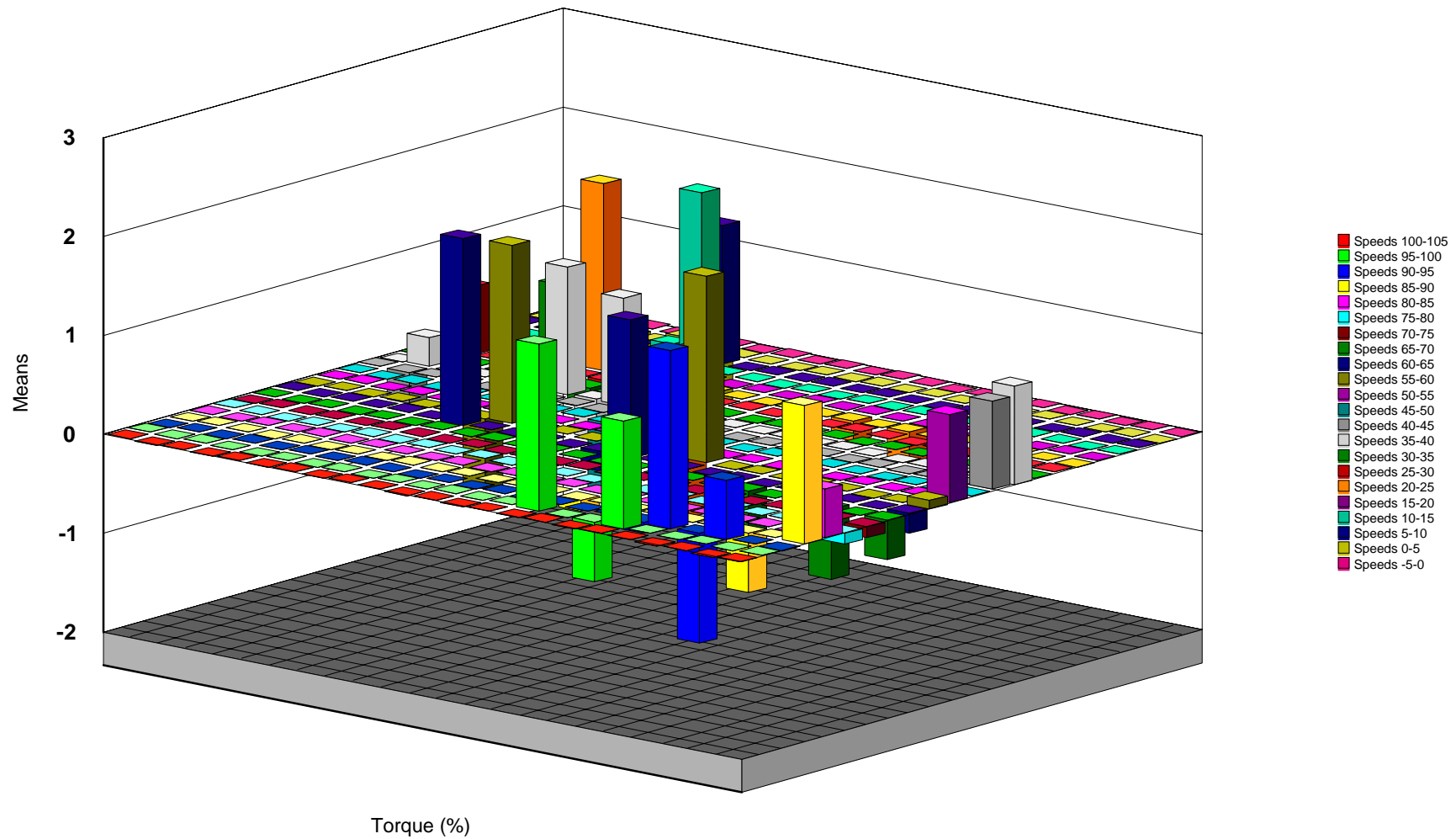
## WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Steady State Counts



# WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Steady State Sums

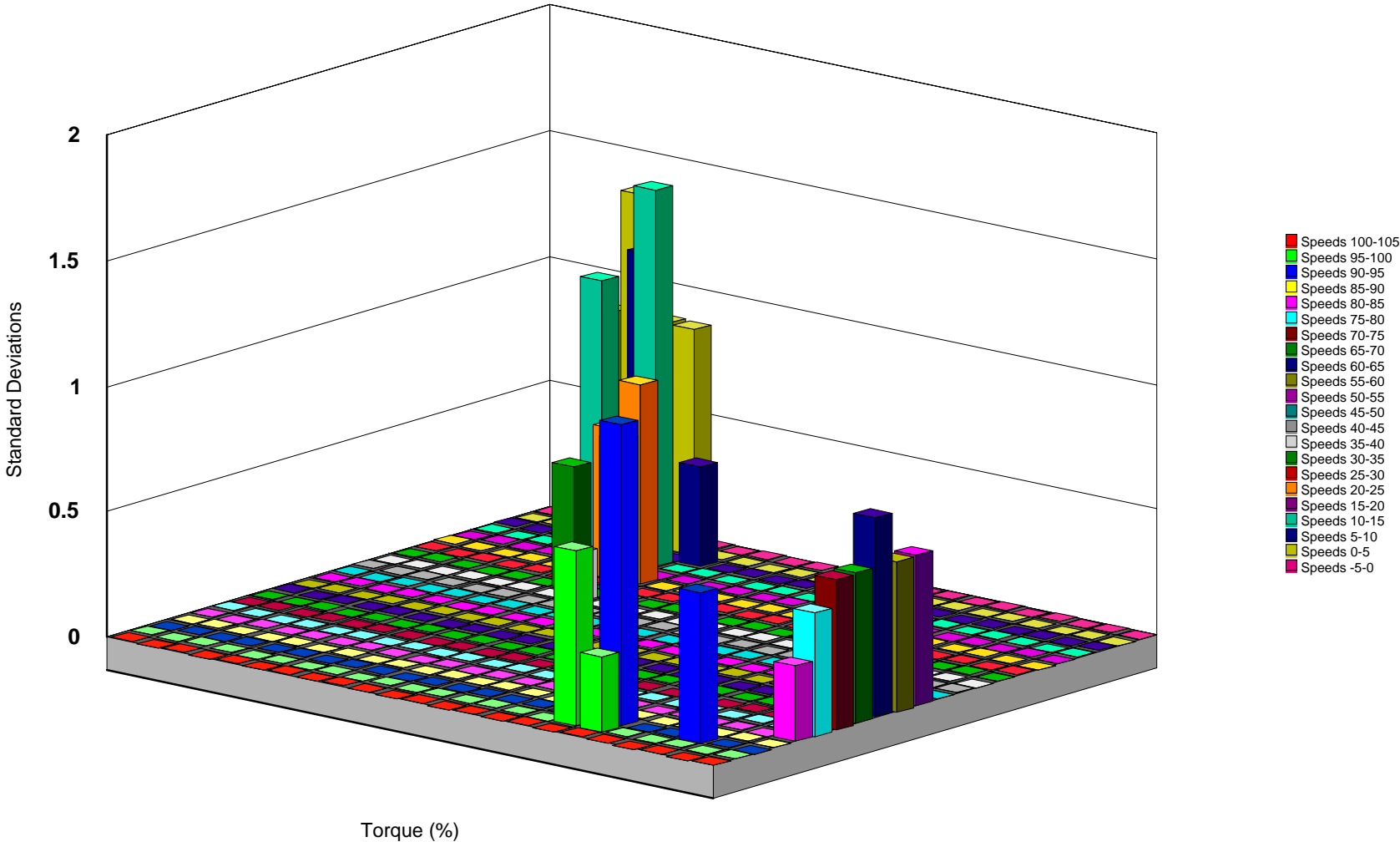


## WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Steady State Means

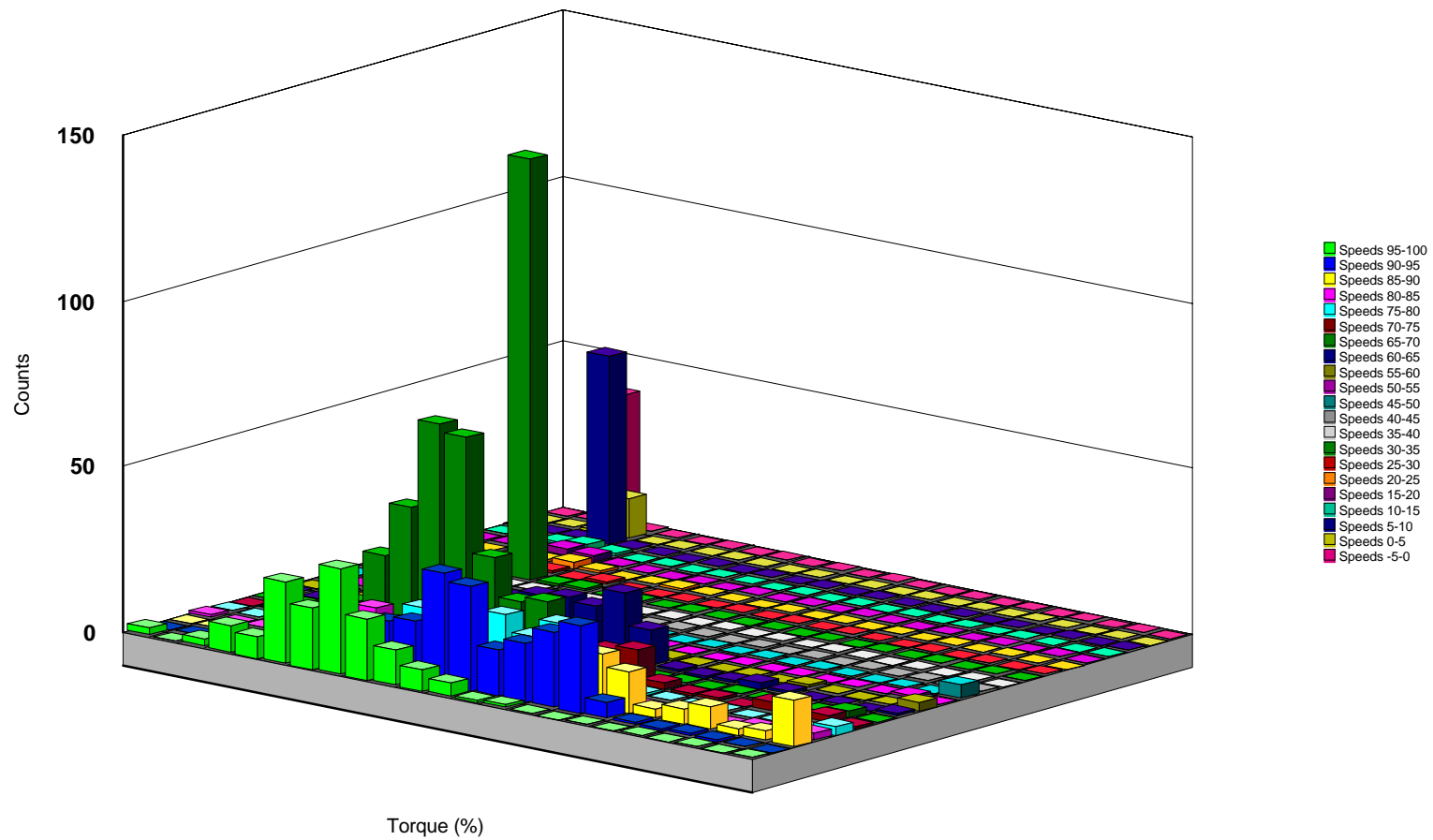




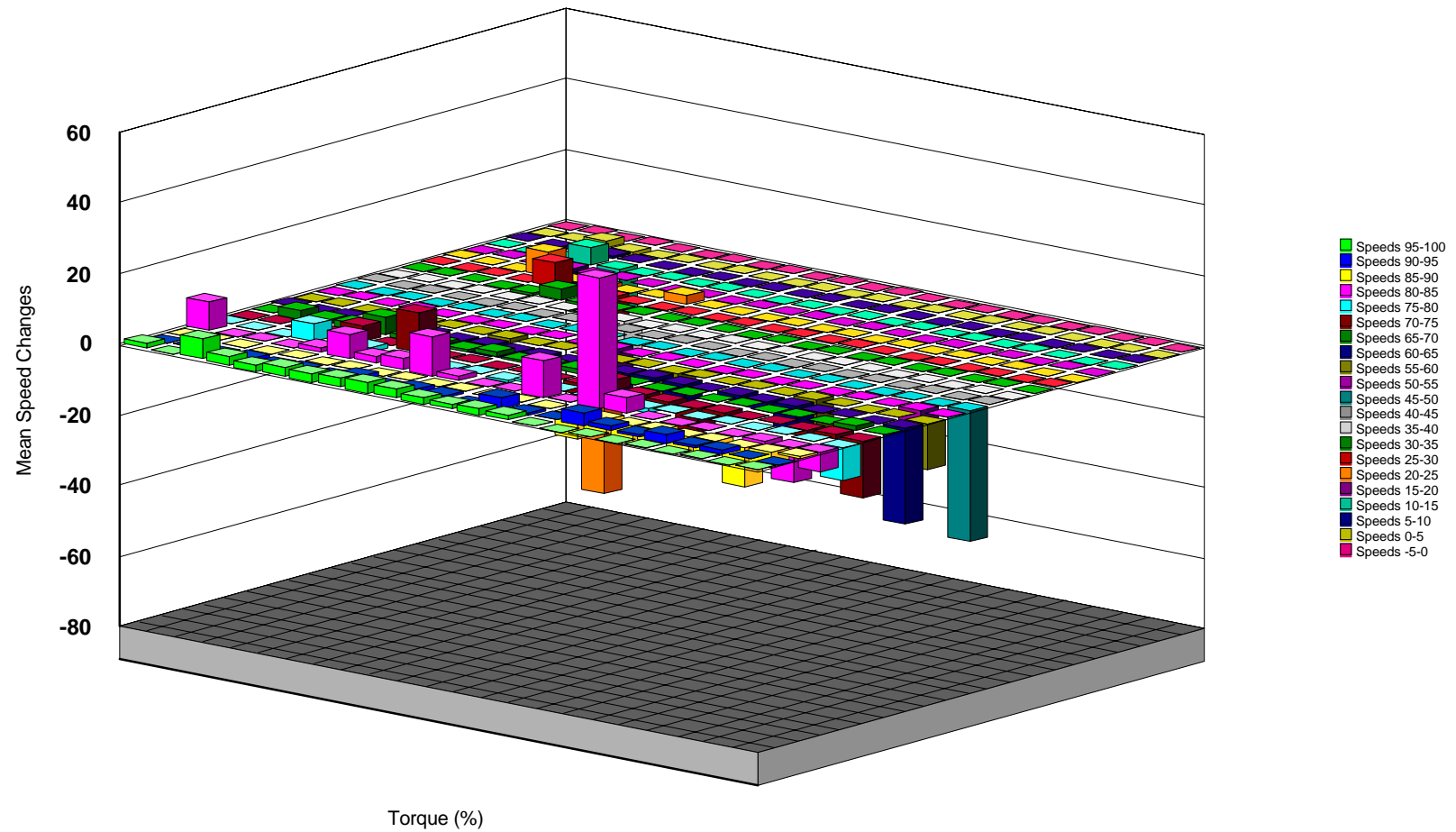
WHEEL LOADER HIGH TORQUE TRANSIENT--Torque Steady State Standard Deviations



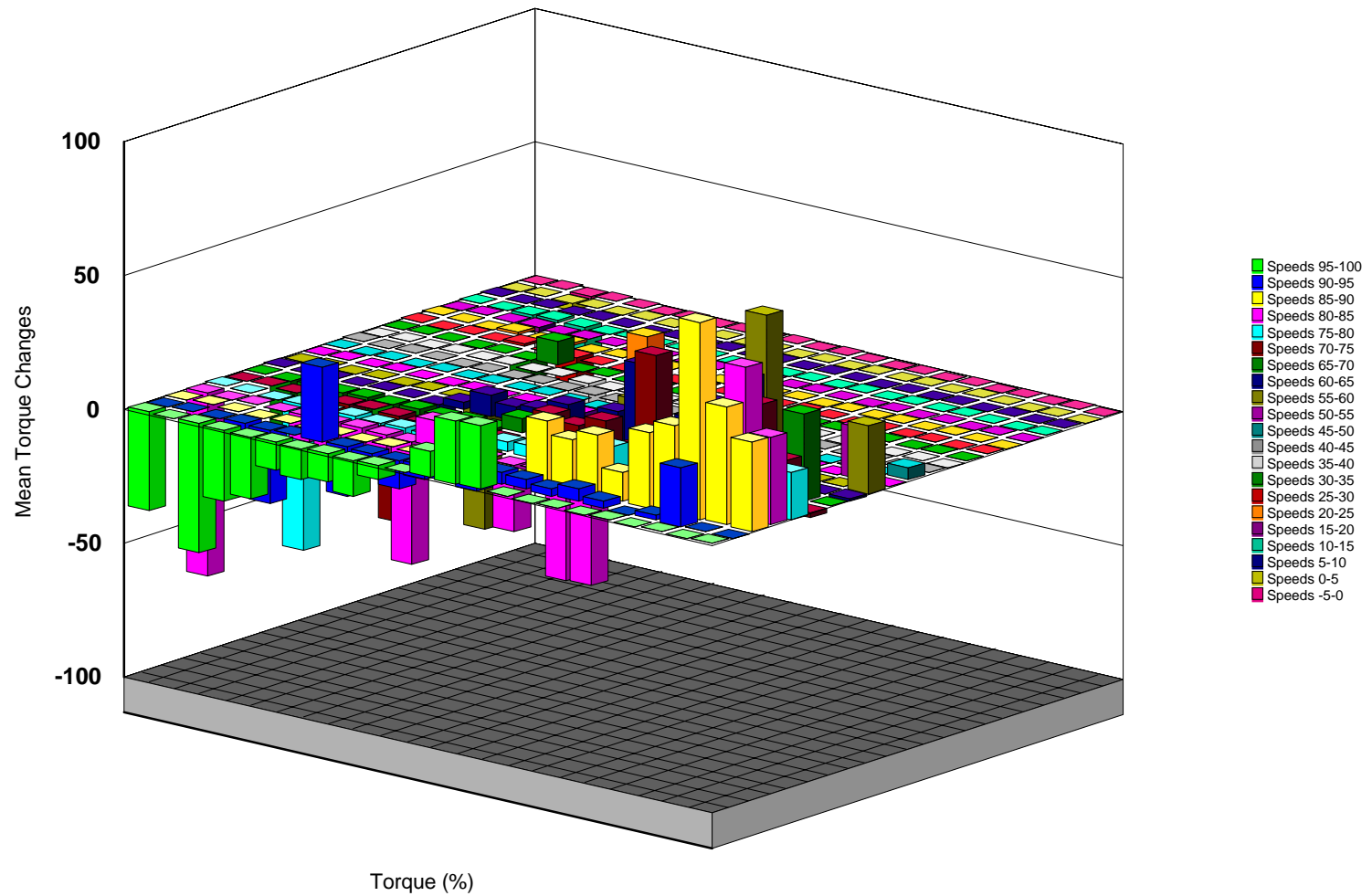
## SKID STEER LOADER TYPICAL 1--Counts



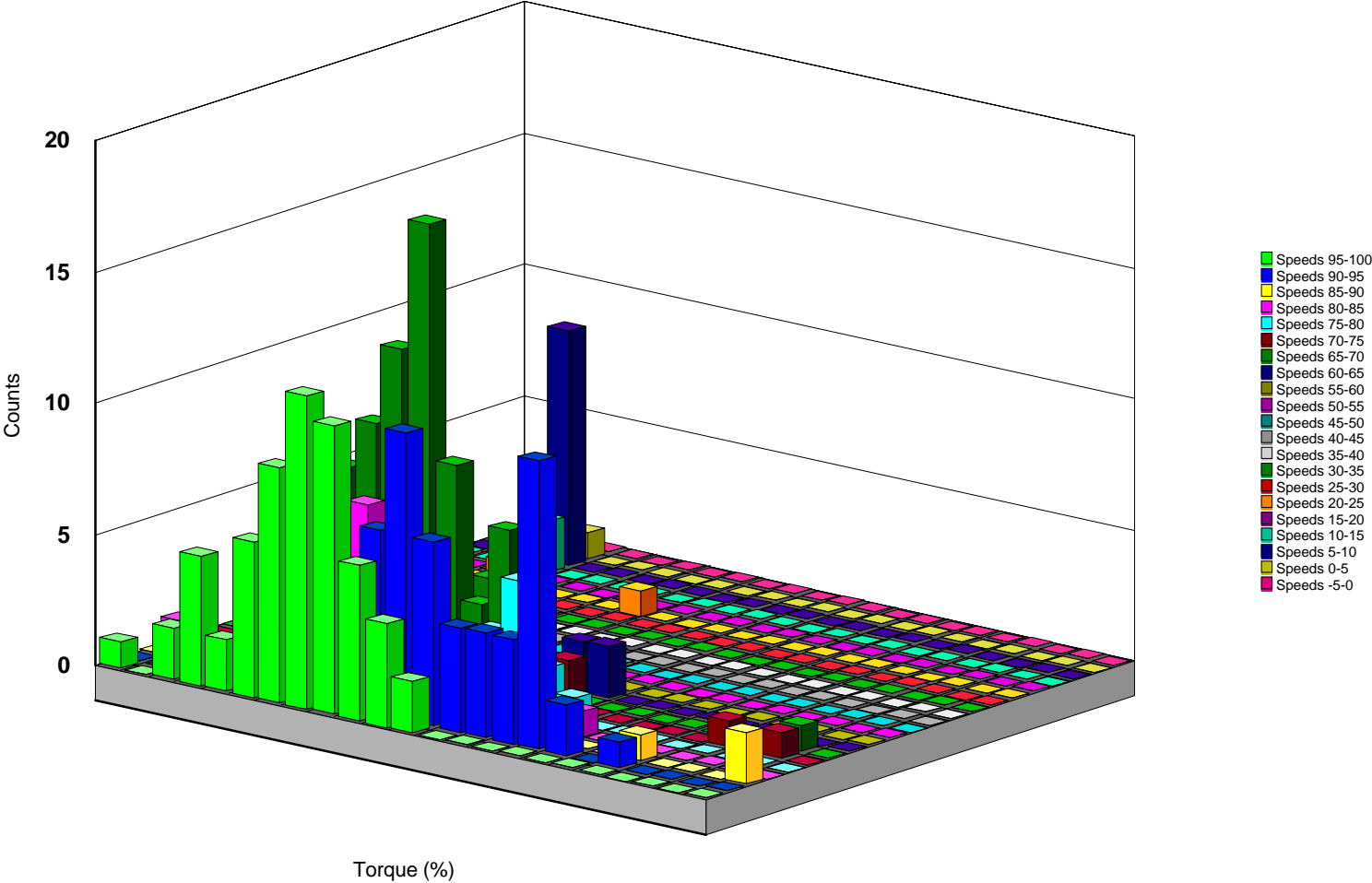
## SKID STEER LOADER TYPICAL 1--Mean Speed Changes



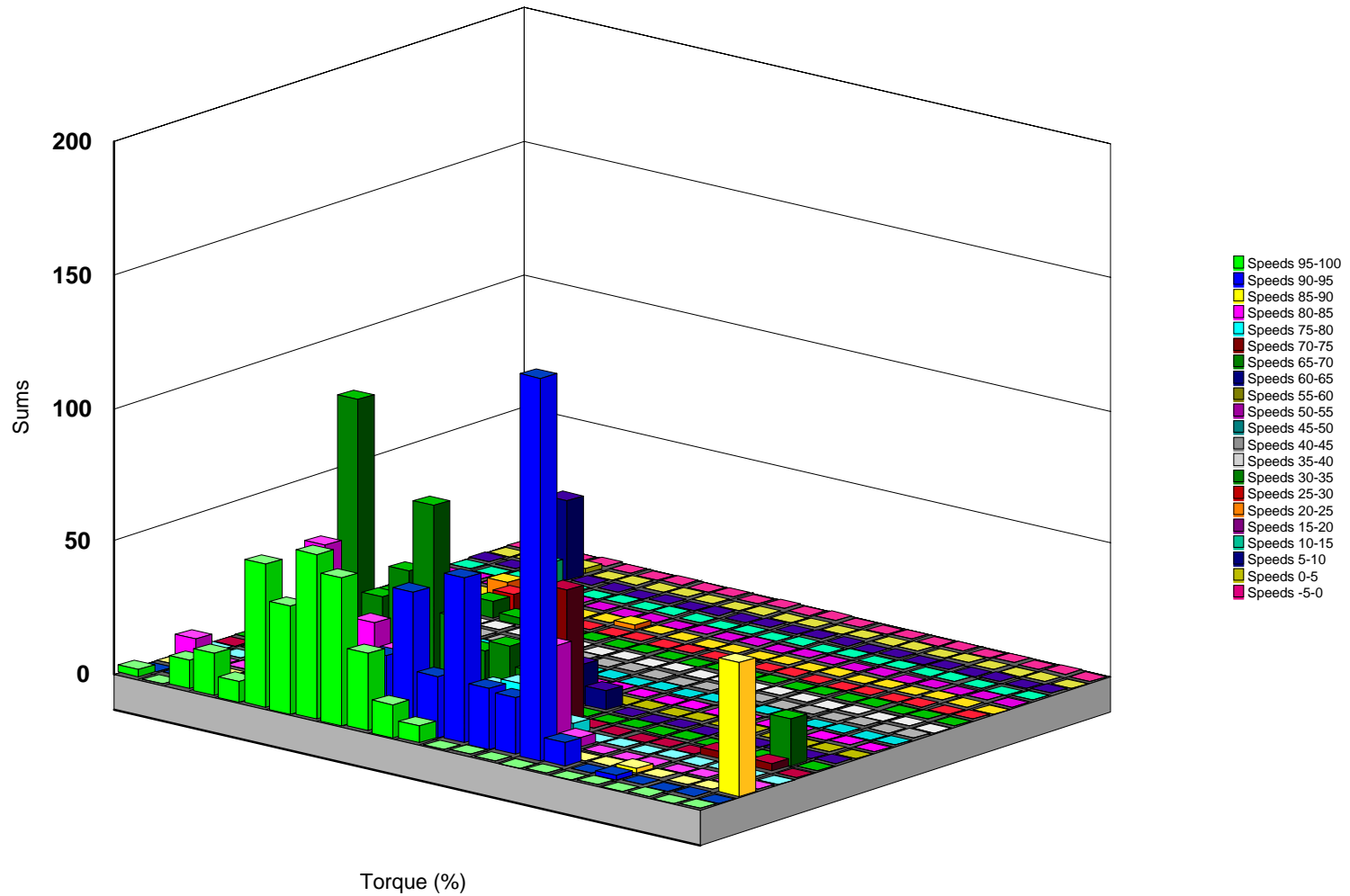
## SKID STEER LOADER TYPICAL 1--Mean Torque Changes



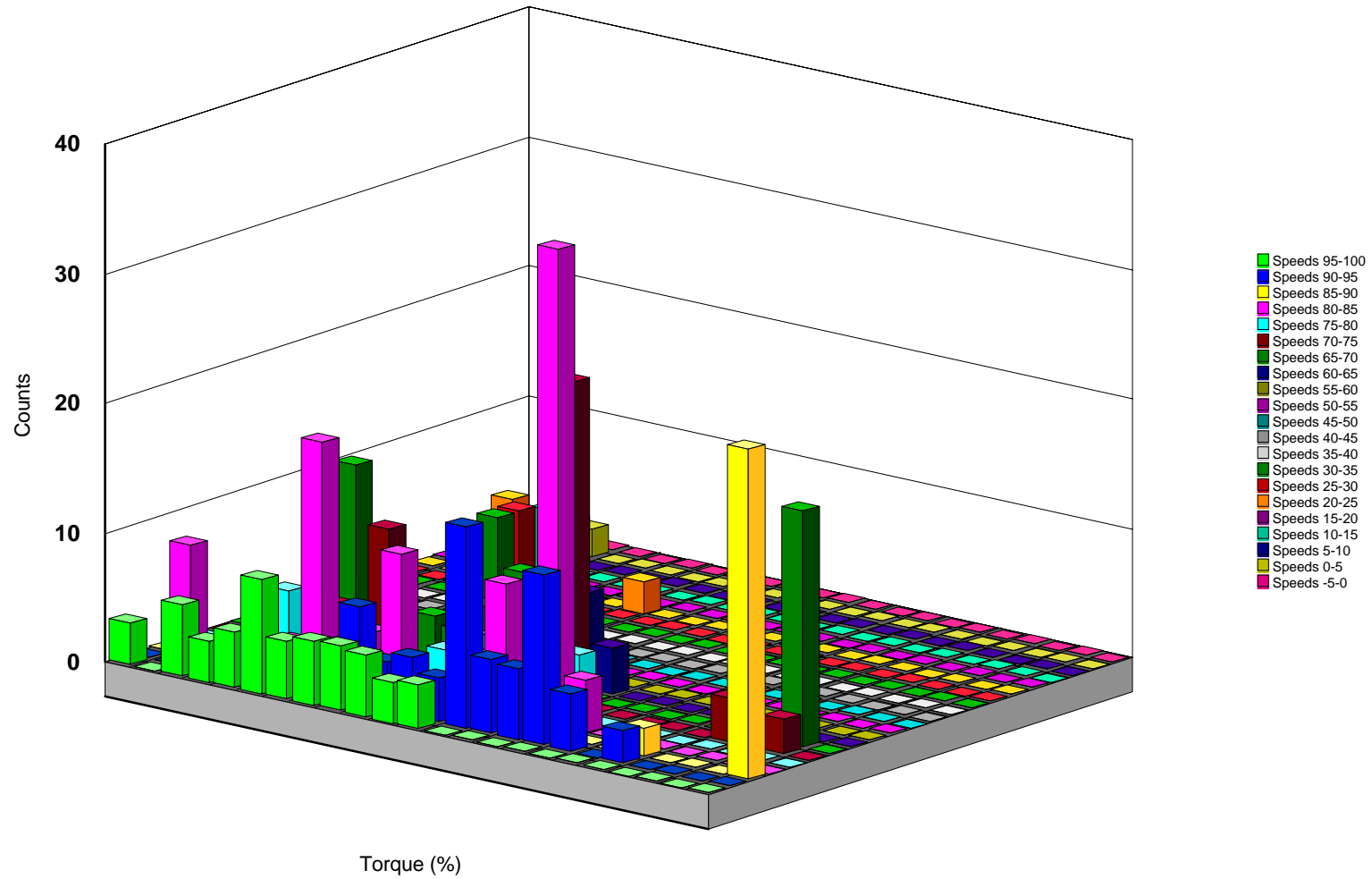
SKID STEER LOADER TYPICAL 1--Speed Acceleration Counts



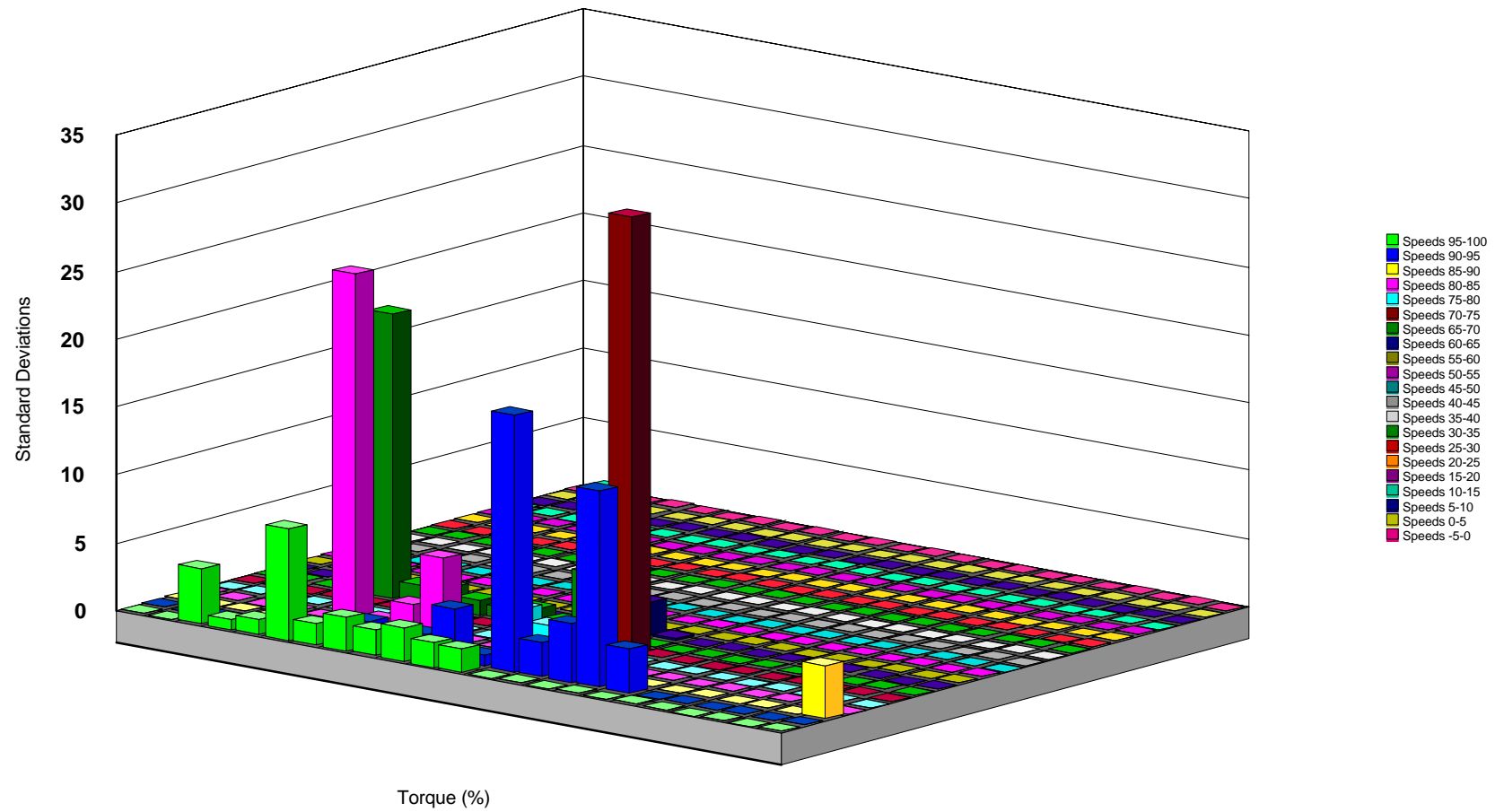
## SKID STEER LOADER TYPICAL 1--Speed Acceleration Sums



## SKID STEER LOADER TYPICAL 1--Speed Acceleration Means

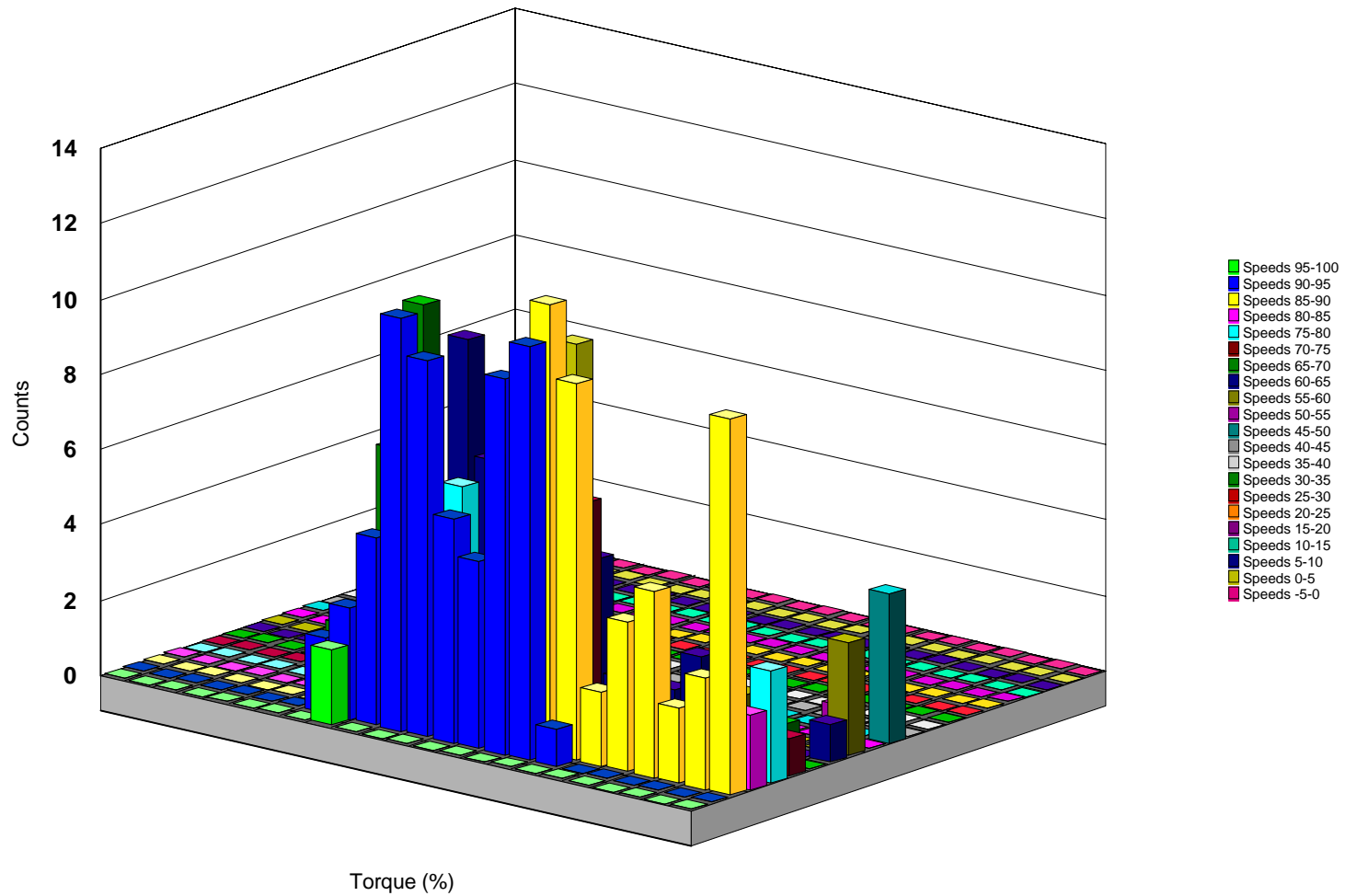


## SKID STEER LOADER TYPICAL 1--Speed Acceleration Standard Deviations

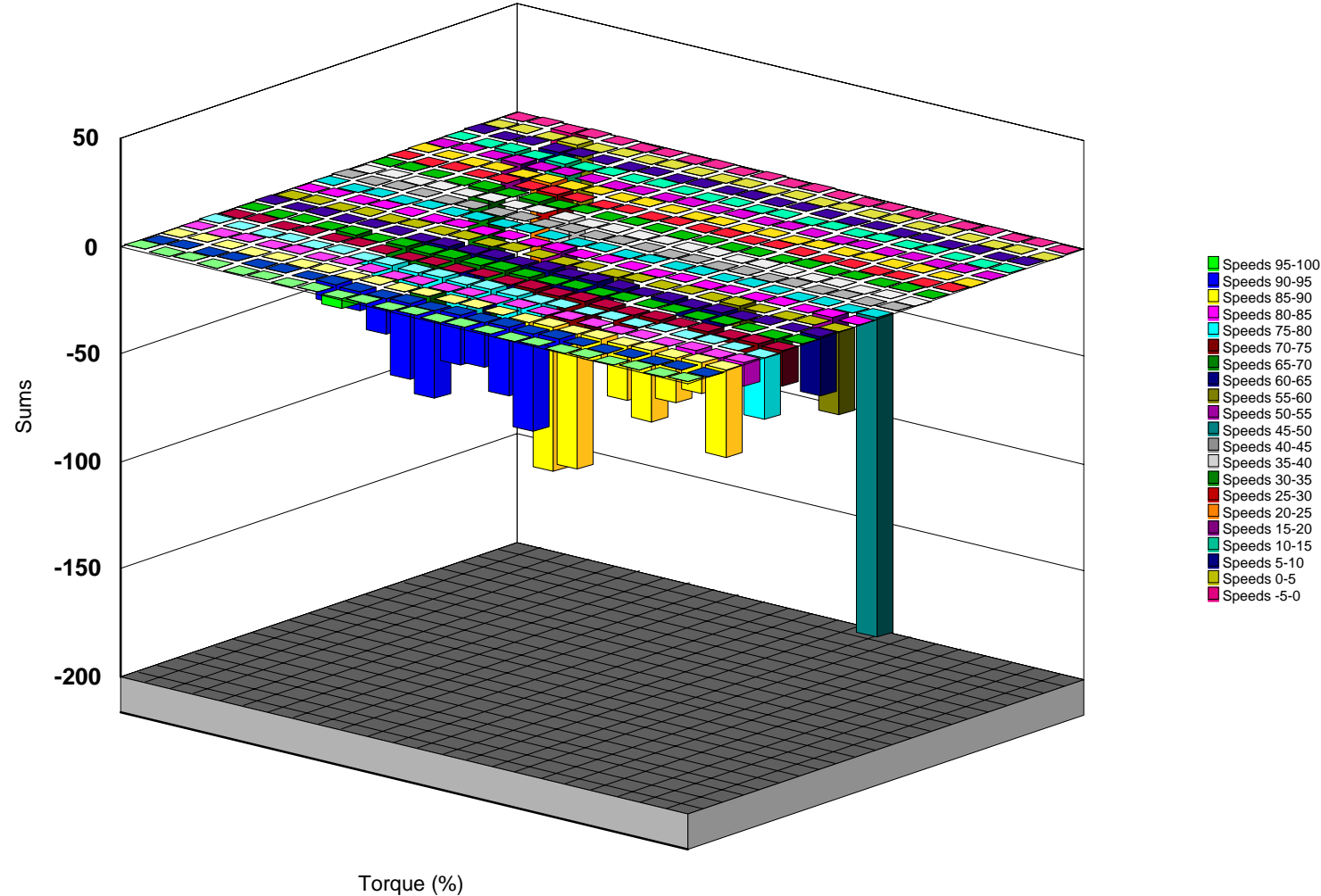




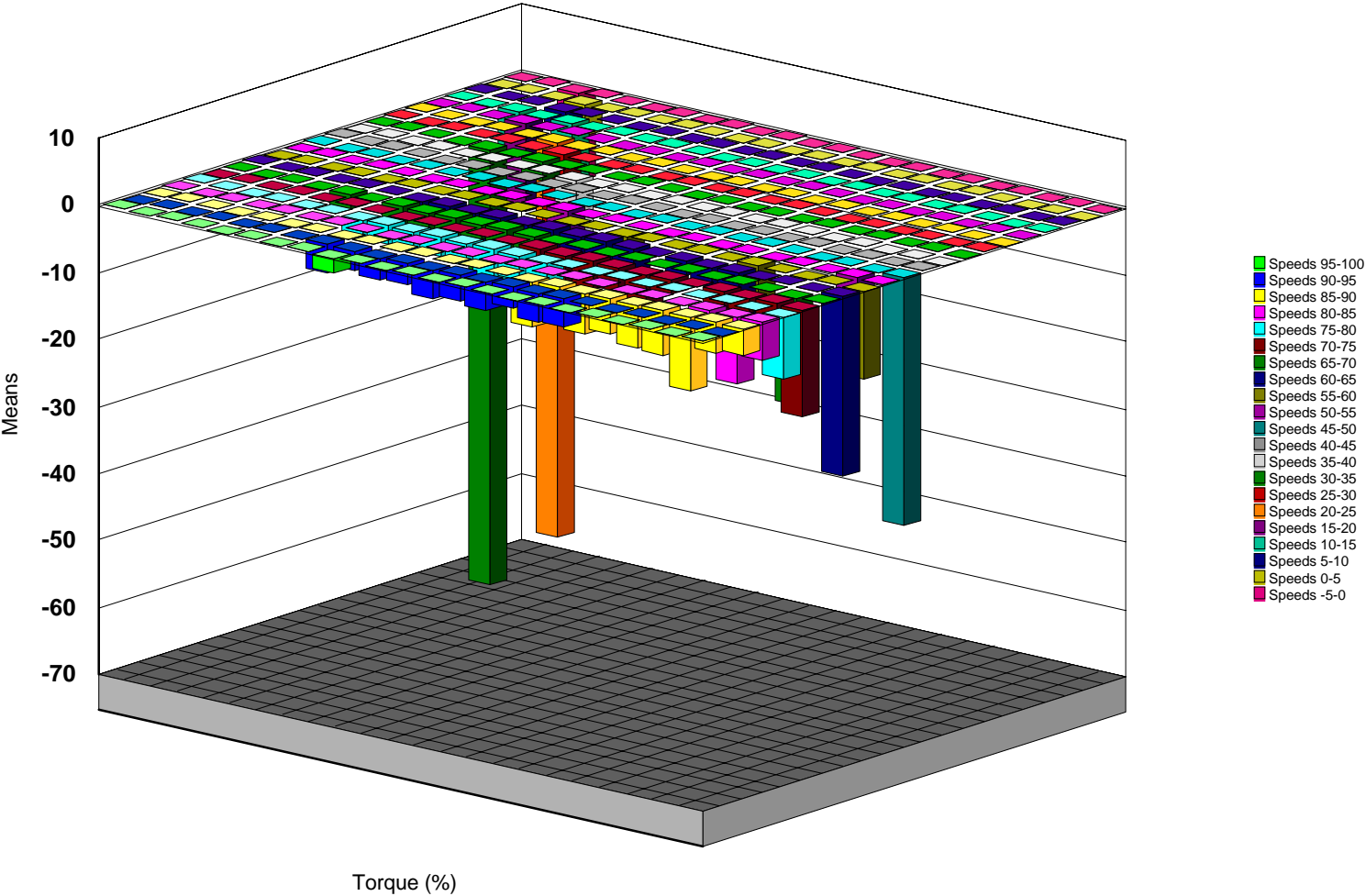
## SKID STEER LOADER TYPICAL 1--Speed Deceleration Counts



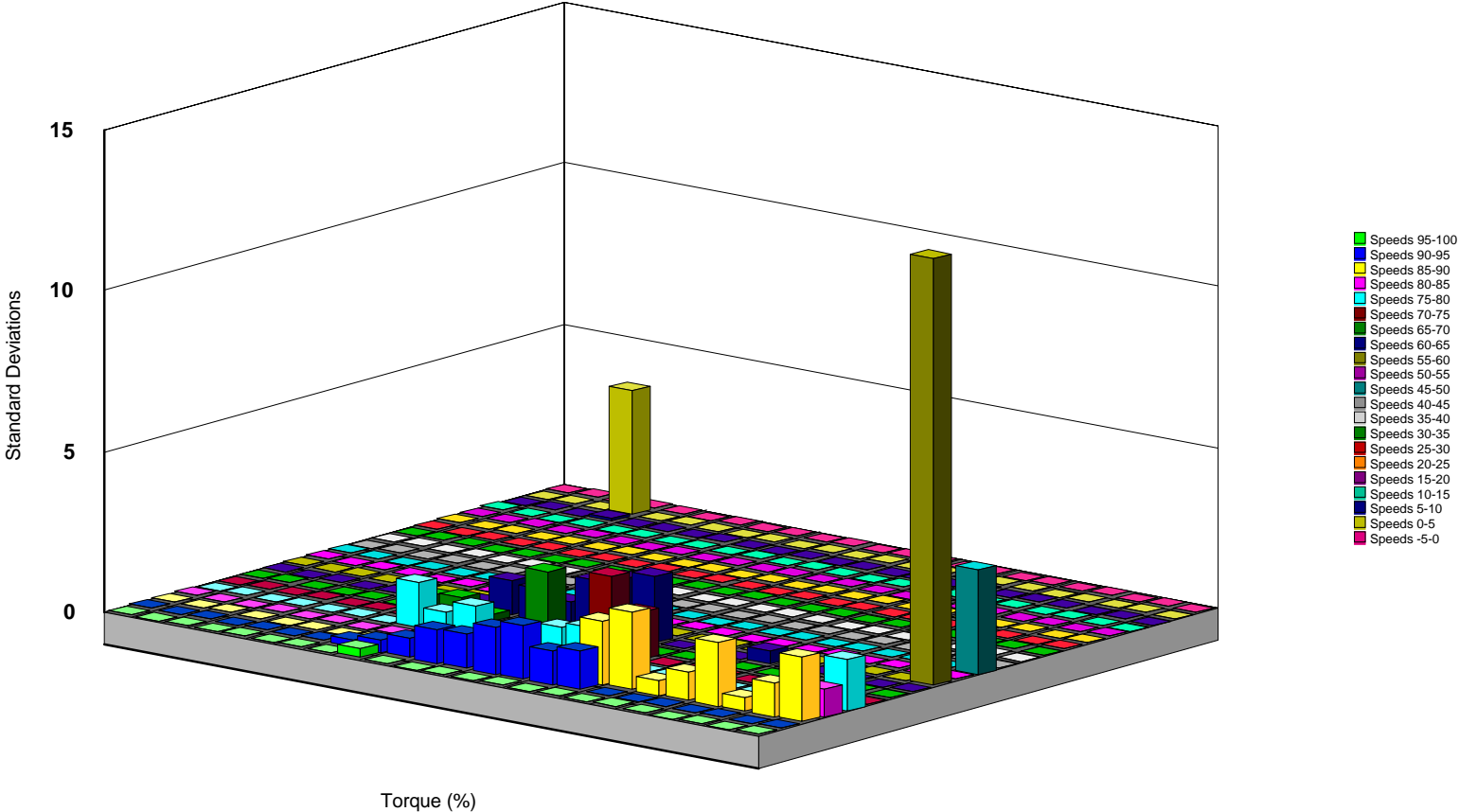
# SKID STEER LOADER--Speed Deceleration Sums



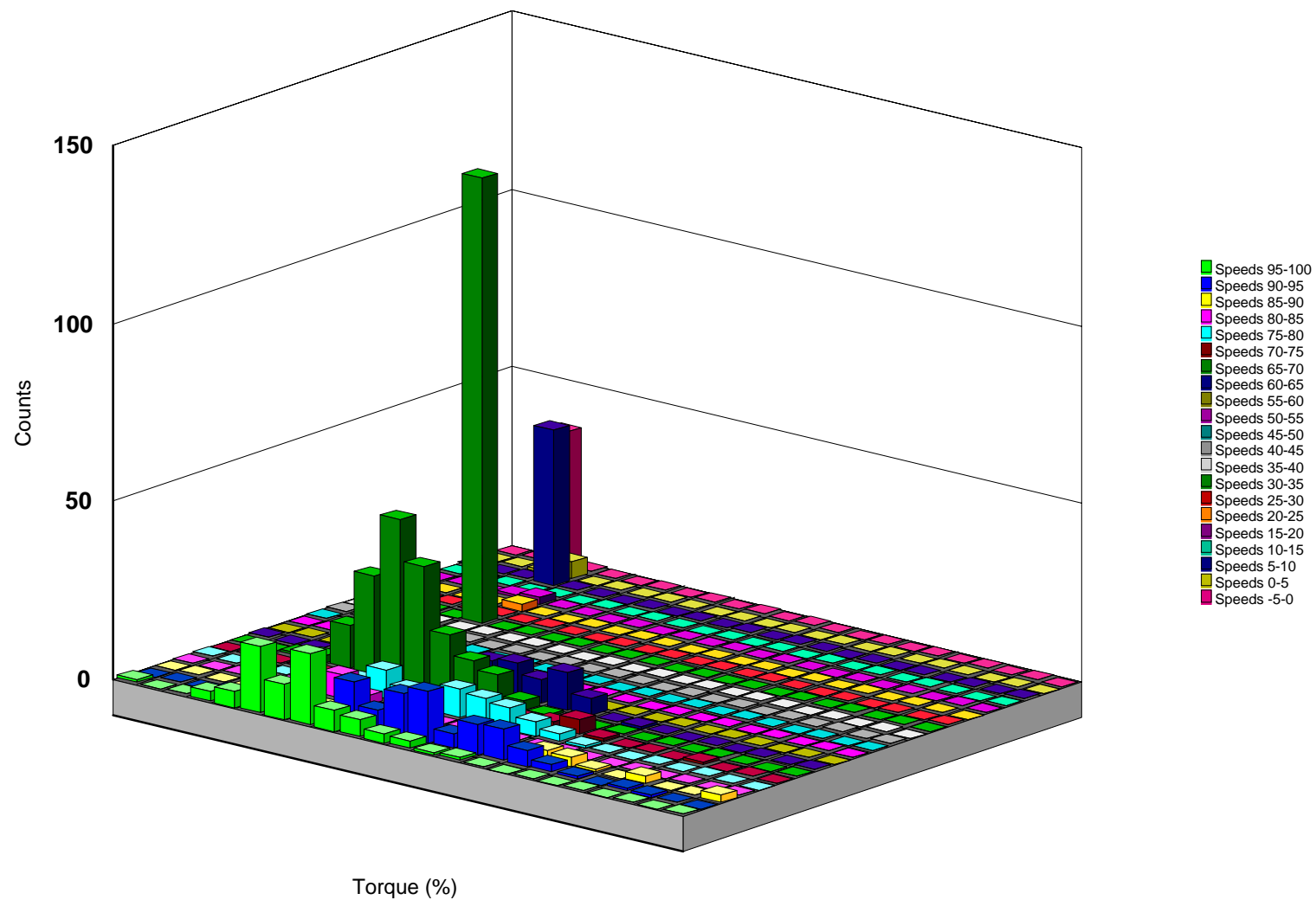
# SKID STEER LOADER TYPICAL 1--Speed Deceleration Means



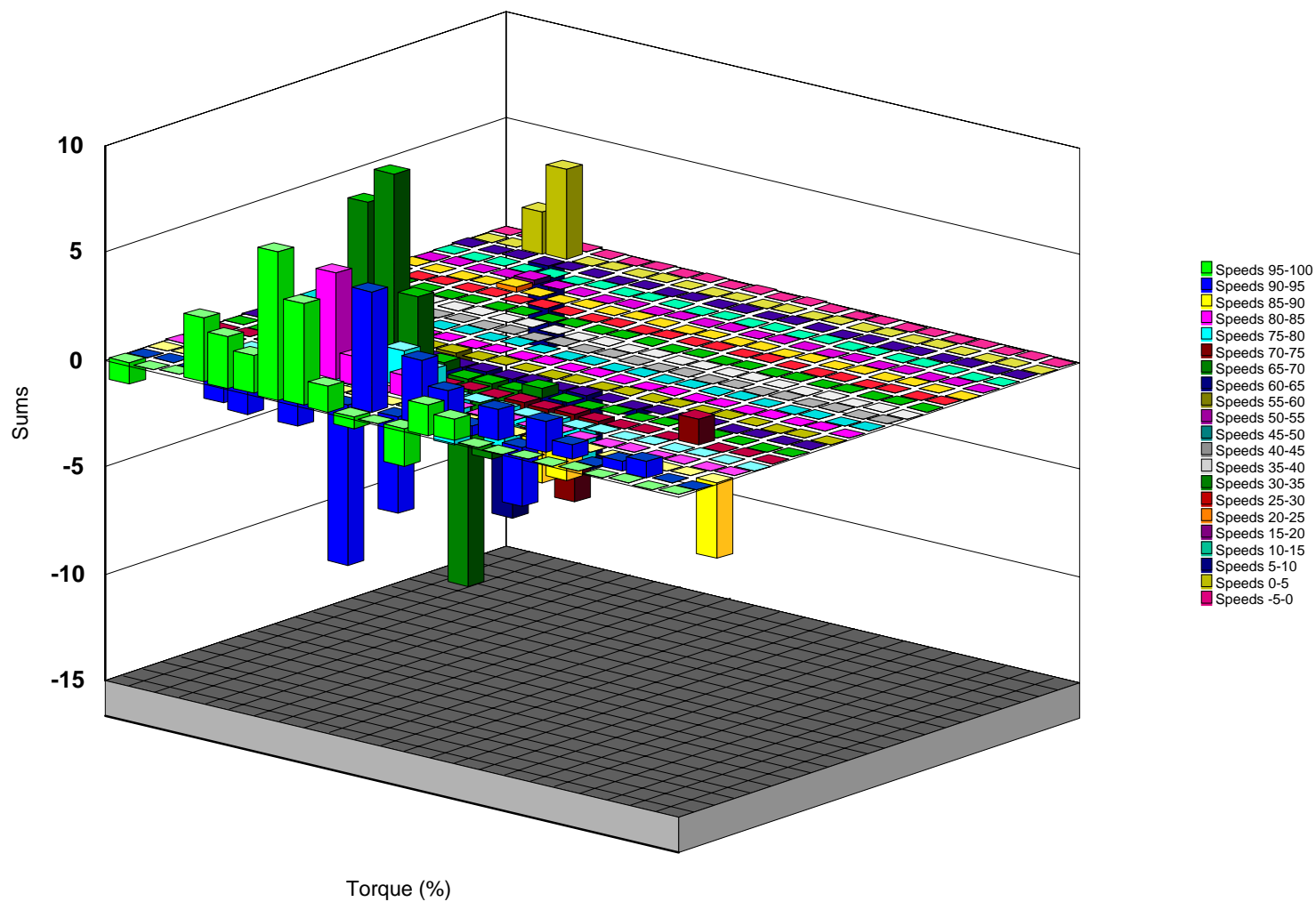
SKID STEER LOADER TYPICAL 1--Speed Deceleration Standard Deviations



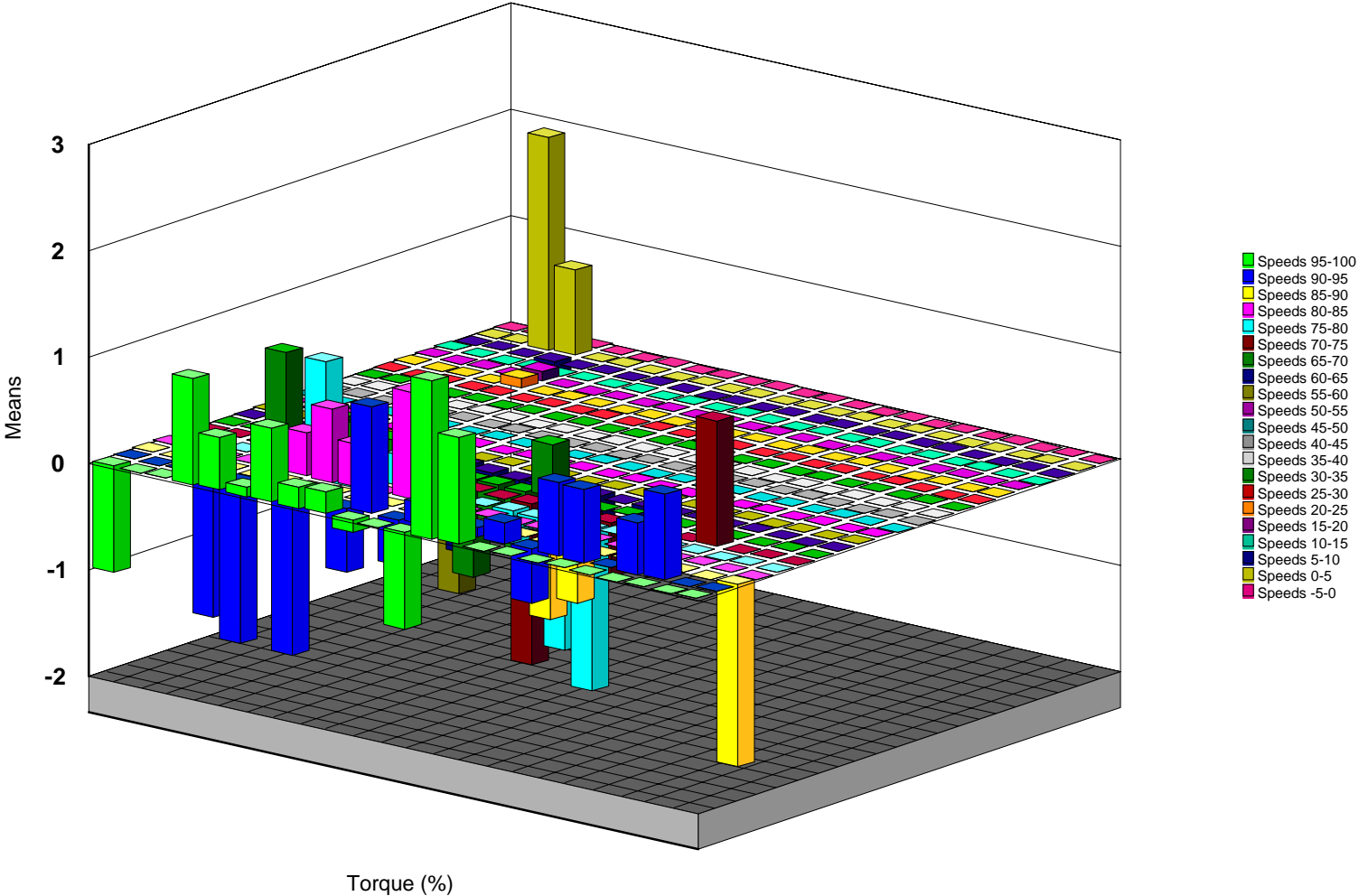
## SKID STEER LOADER TYPICAL 1--Speed Steady State Counts



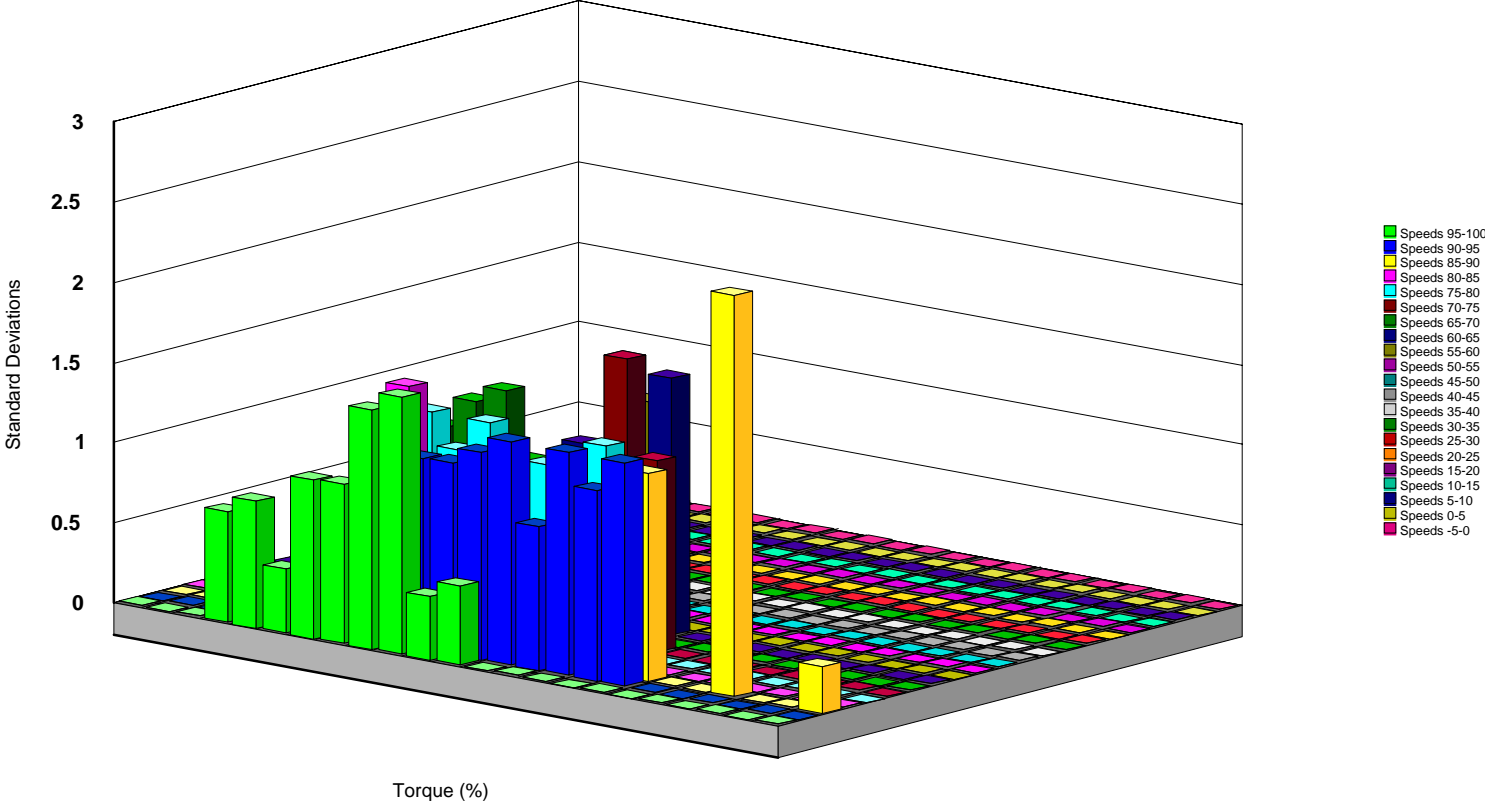
## SKID STEER LOADER TYPICAL 1--Speed Steady State Sums



SKID STEER LOADER TYPICAL 1--Speed Steady State Means

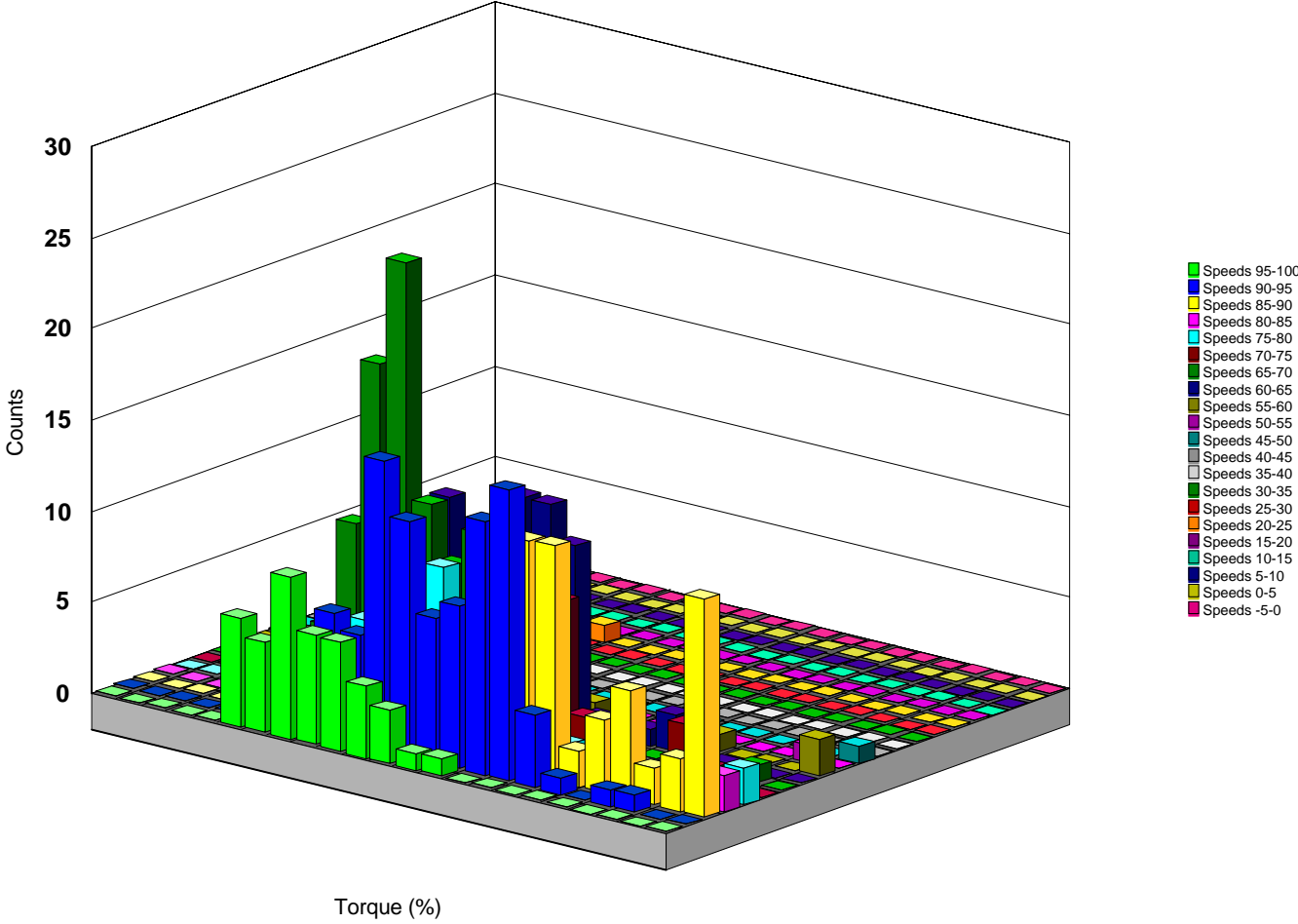


SKID STEER LOADER TYPICAL 1--Speed Steady State Standard Deviations

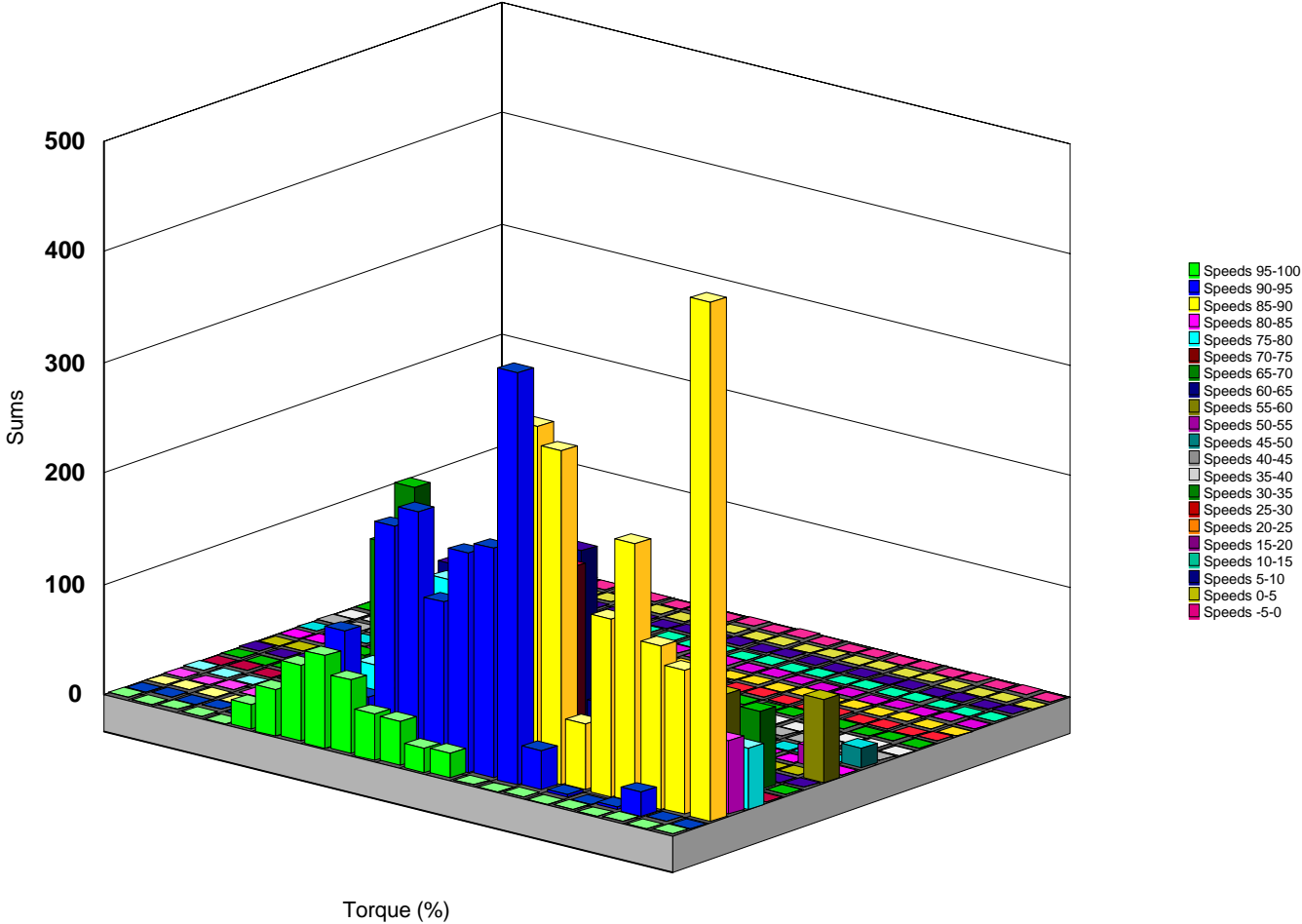




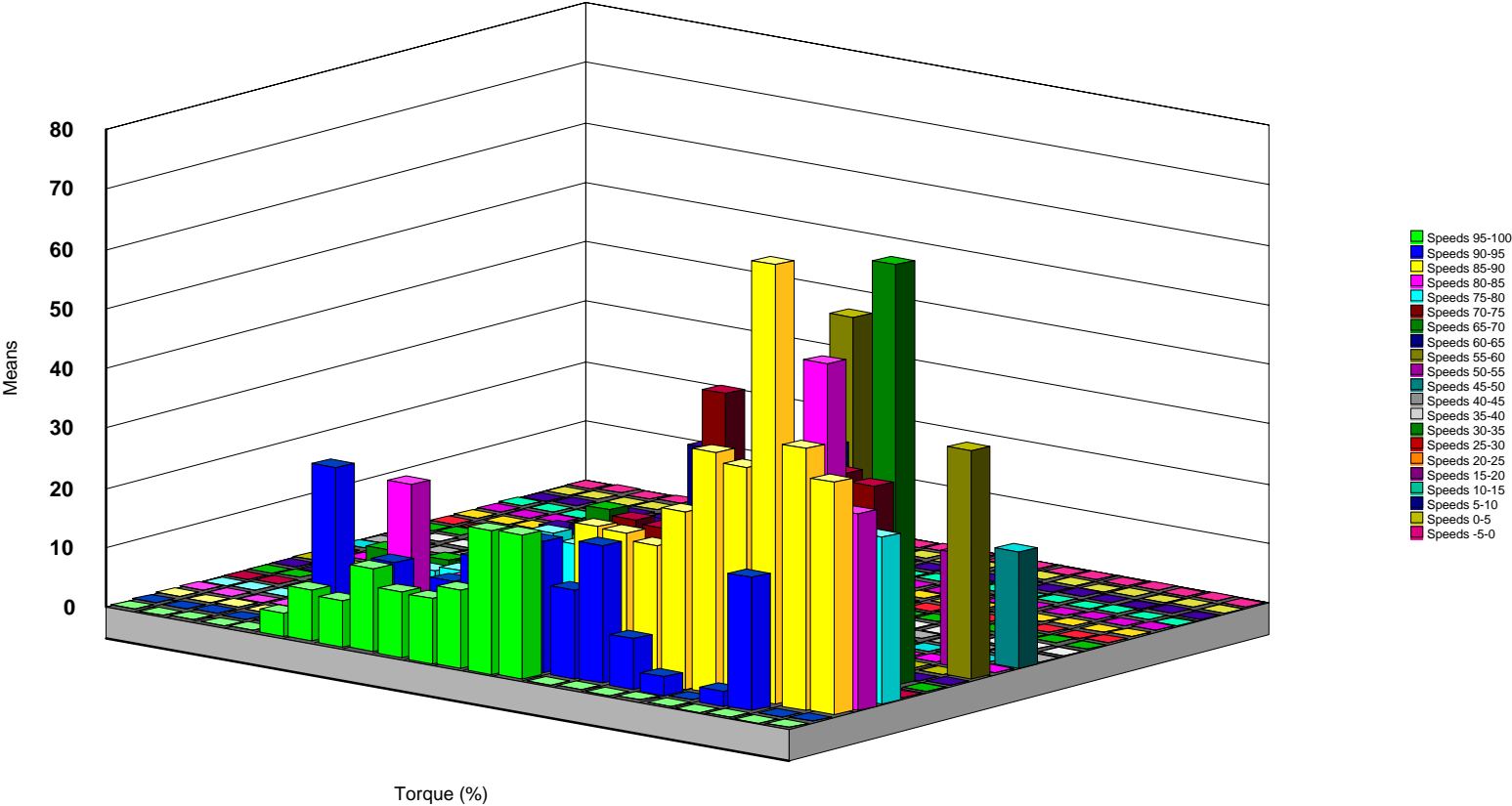
# SKID STEER LOADER TYPICAL 1--Torque Acceleration Counts



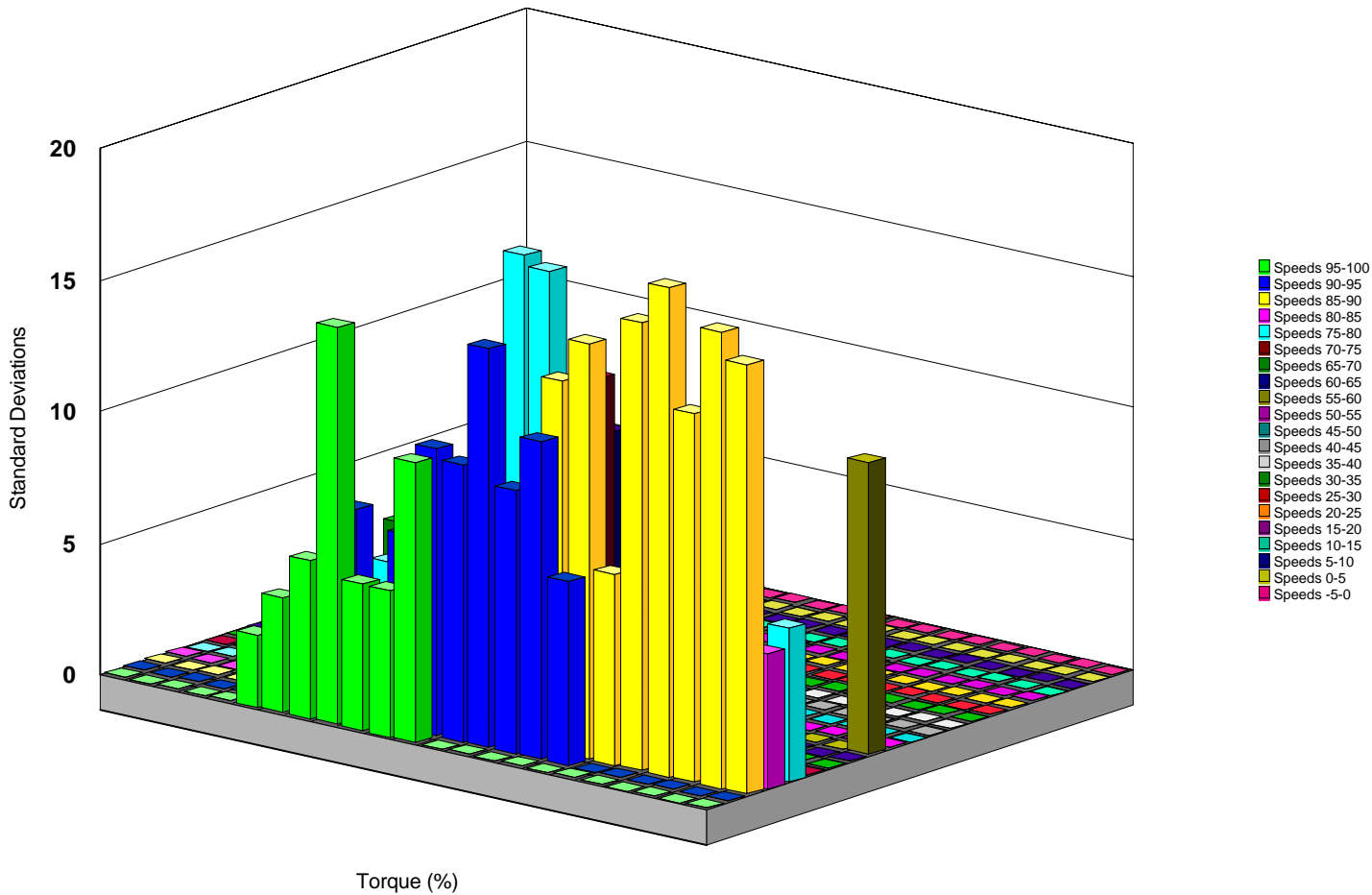
# SKID STEER LOADER TYPICAL 1--Torque Acceleration Sums



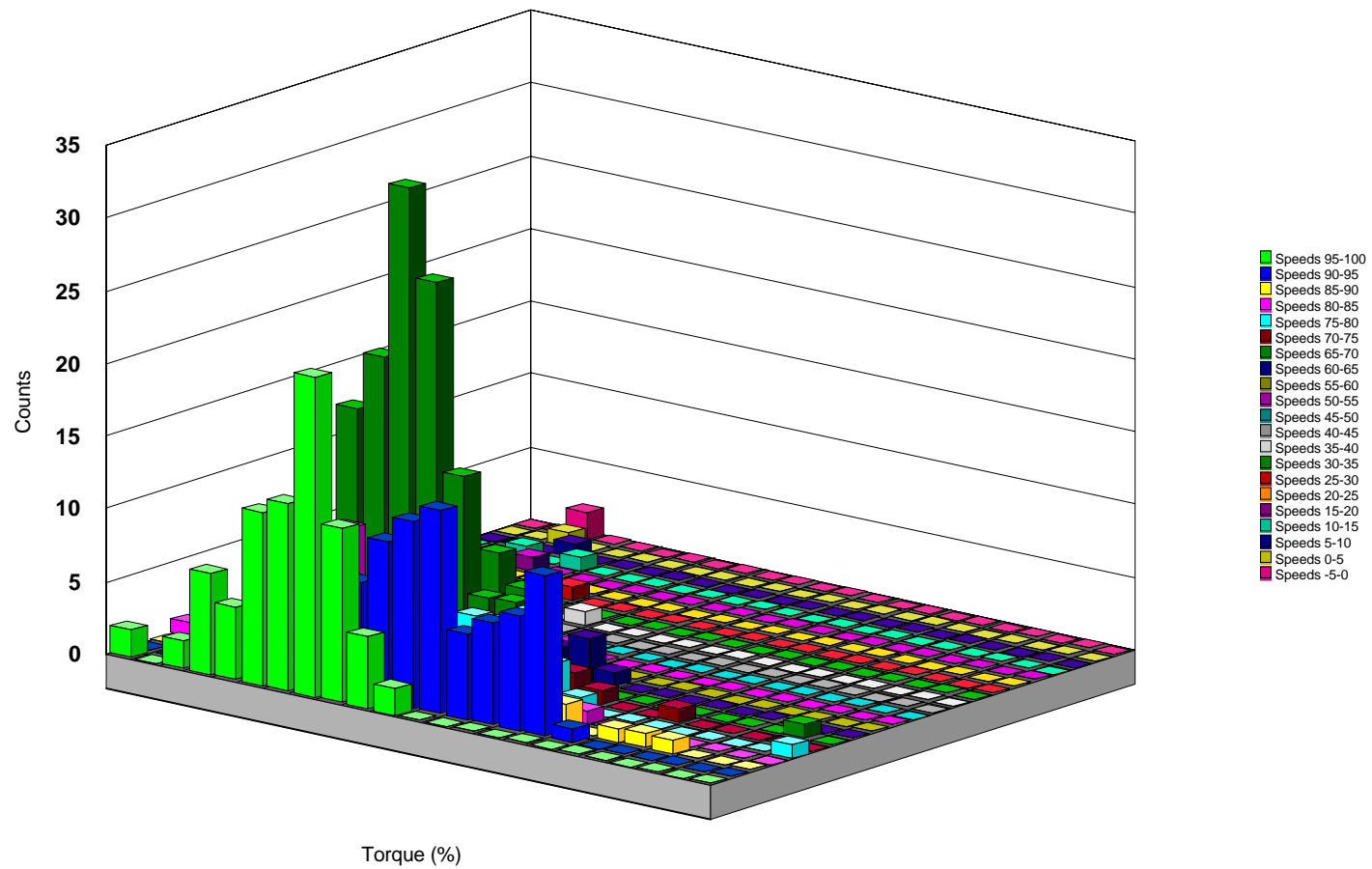
SKID STEER LOADER TYPICAL 1--Torque Acceleration Means



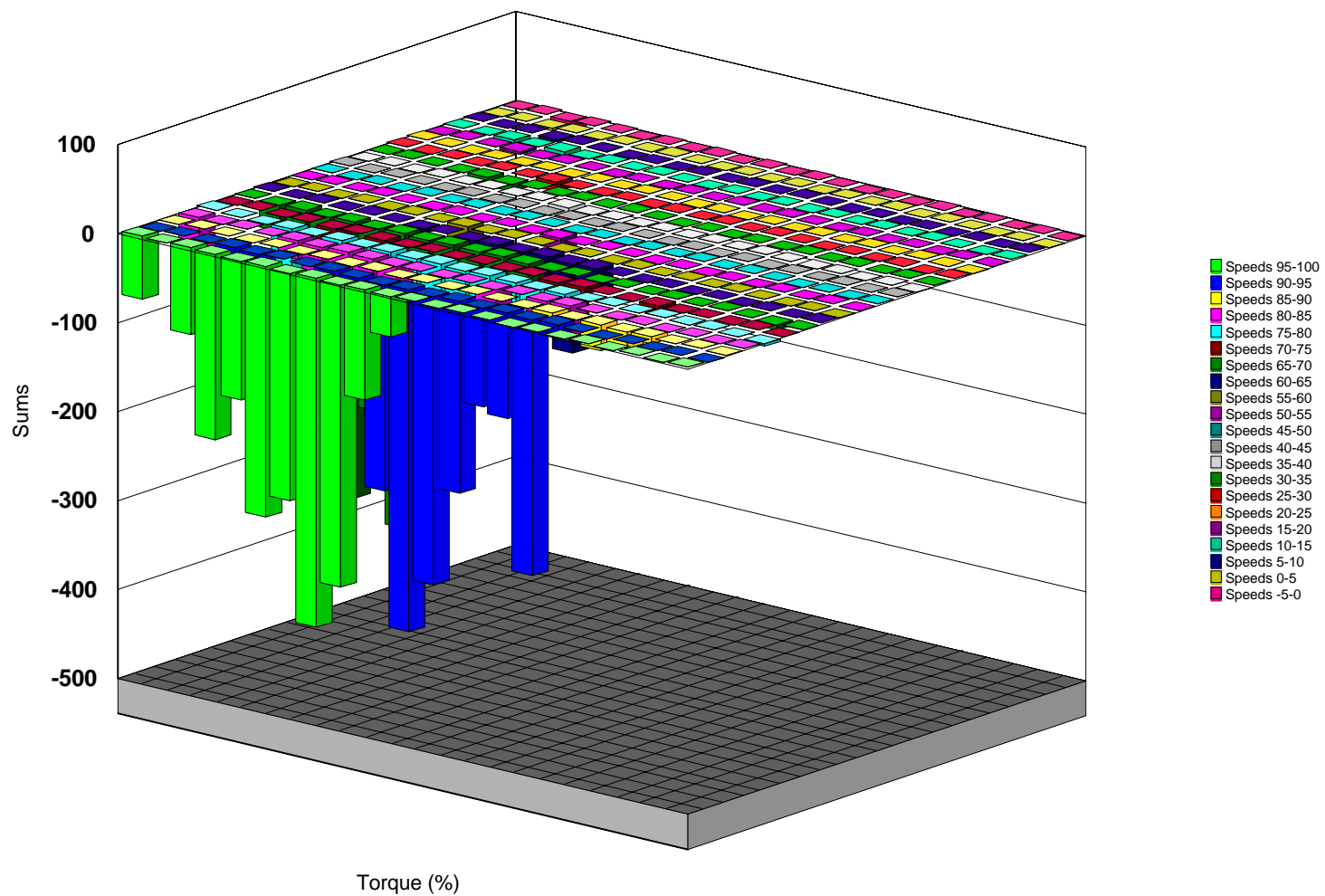
## SKID STEER LOADER TYPICAL 1--Torque Acceleration Standard Deviations



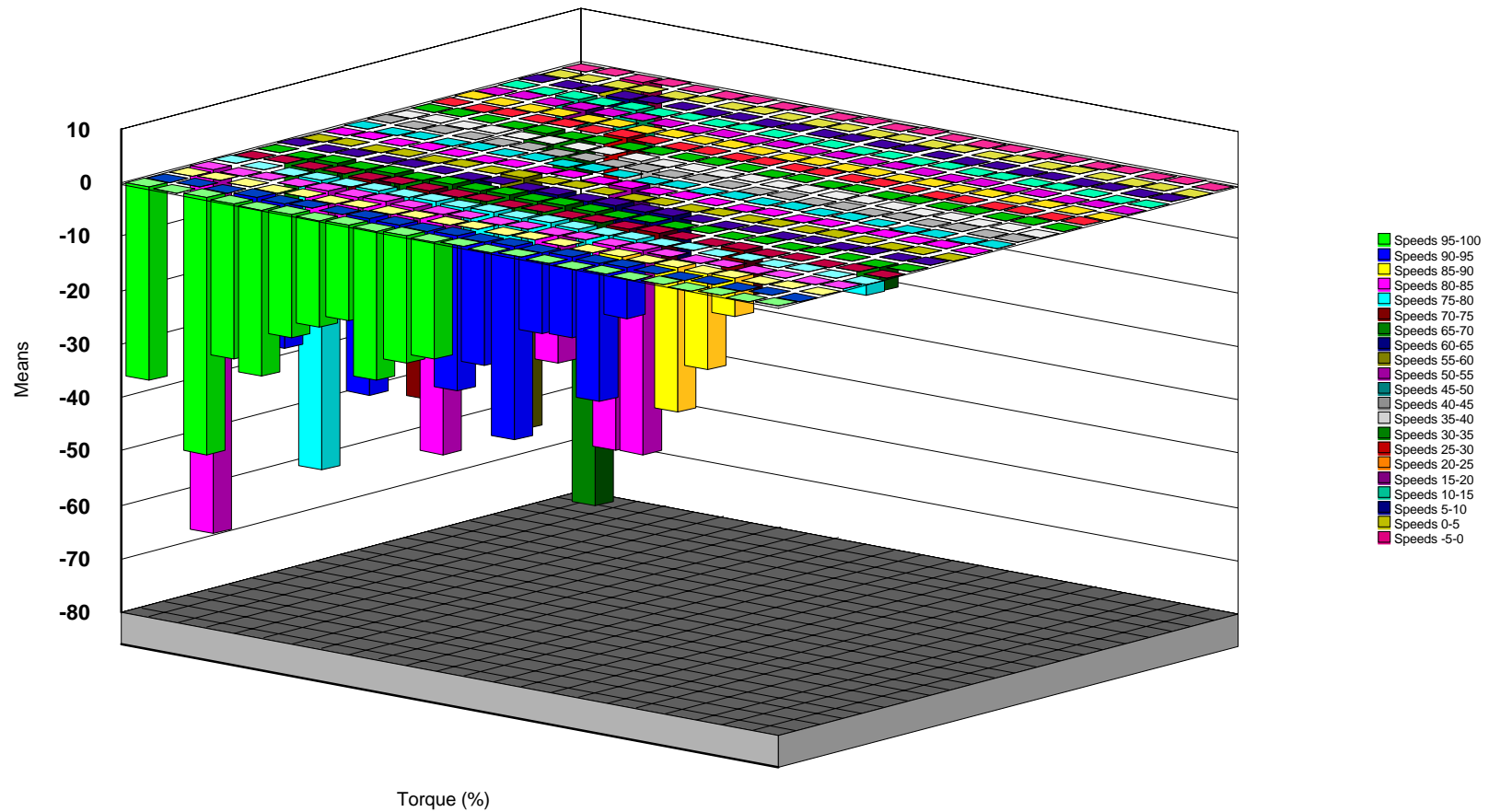
## SKID STEER LOADER TYPICAL 1--Torque Deceleration Counts



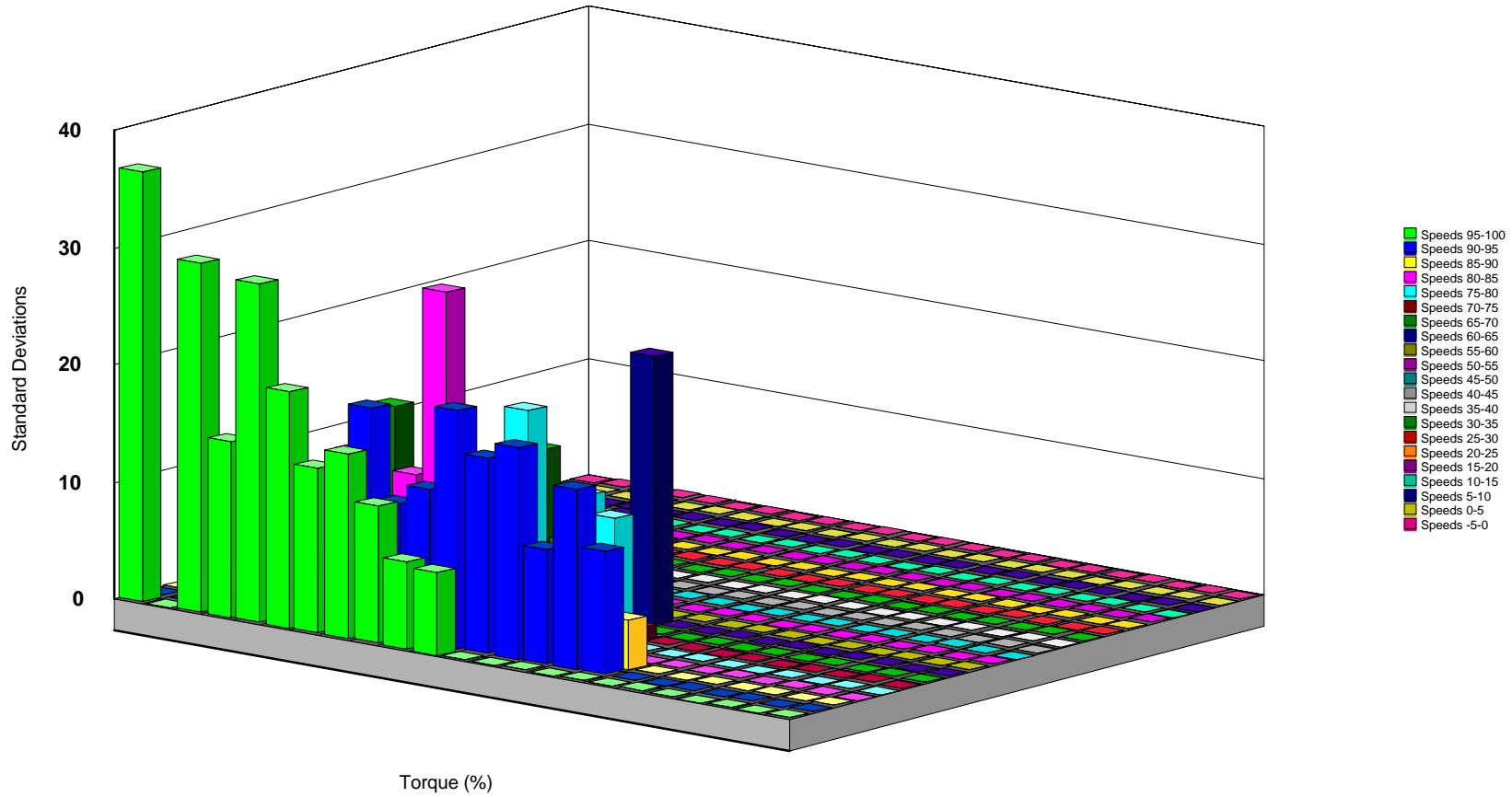
## SKID STEER LOADER TYPICAL 1--Torque Deceleration Sums



## SKID STEER LOADER TYPICAL 1--Torque Deceleration Means

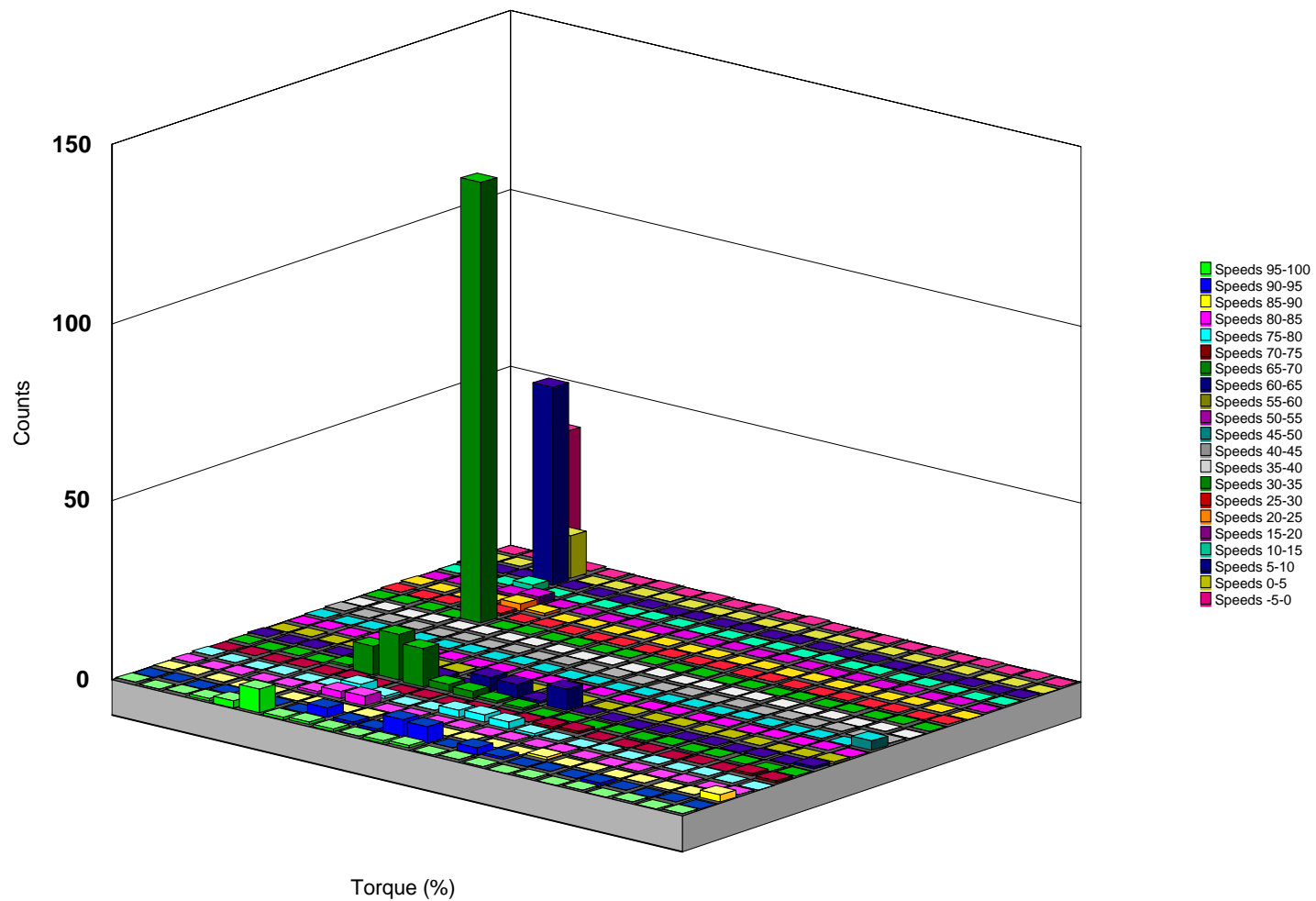


## SKID STEER LOADER TYPICAL 1--Torque Deceleration Standard Deviations

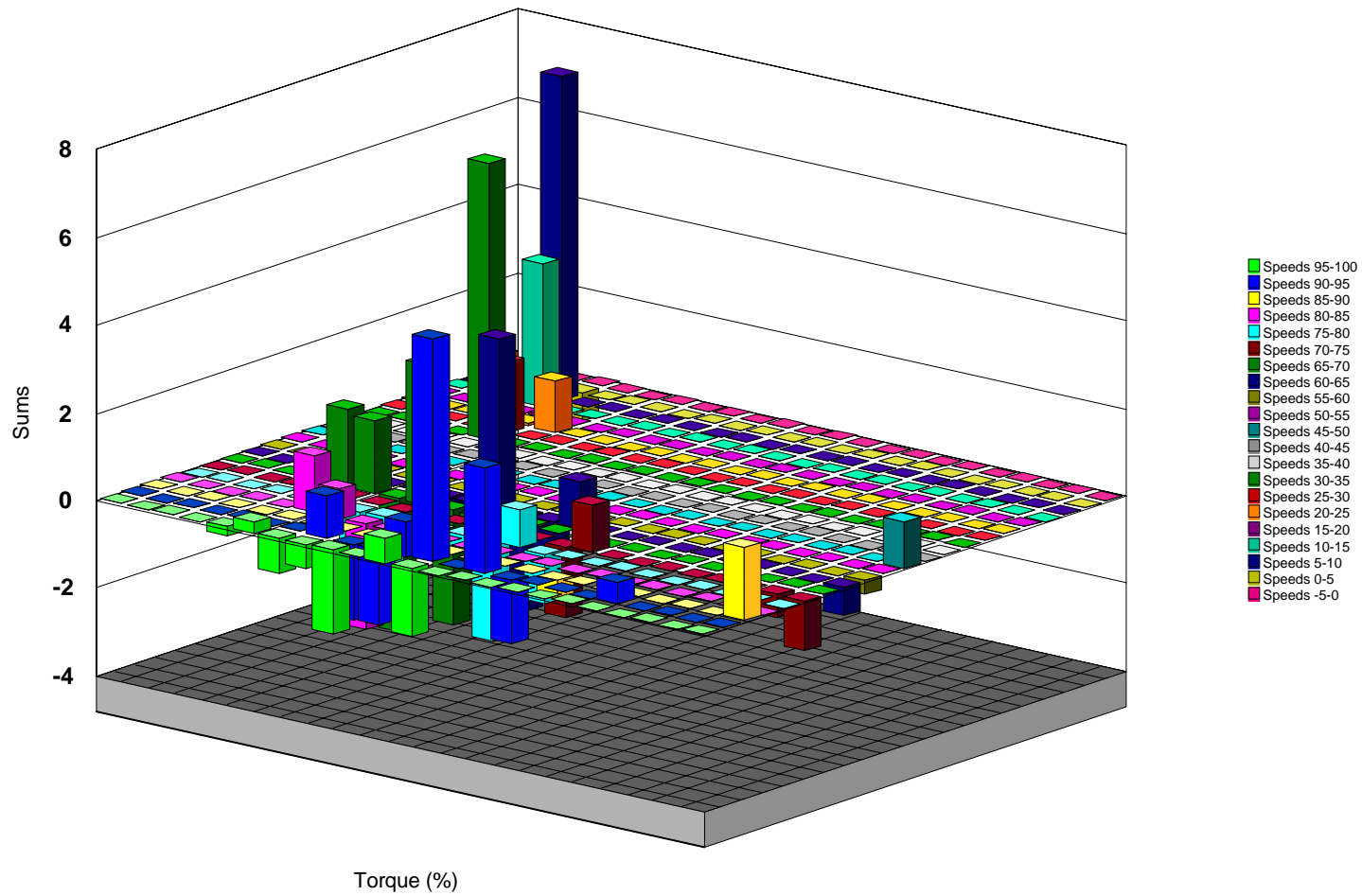




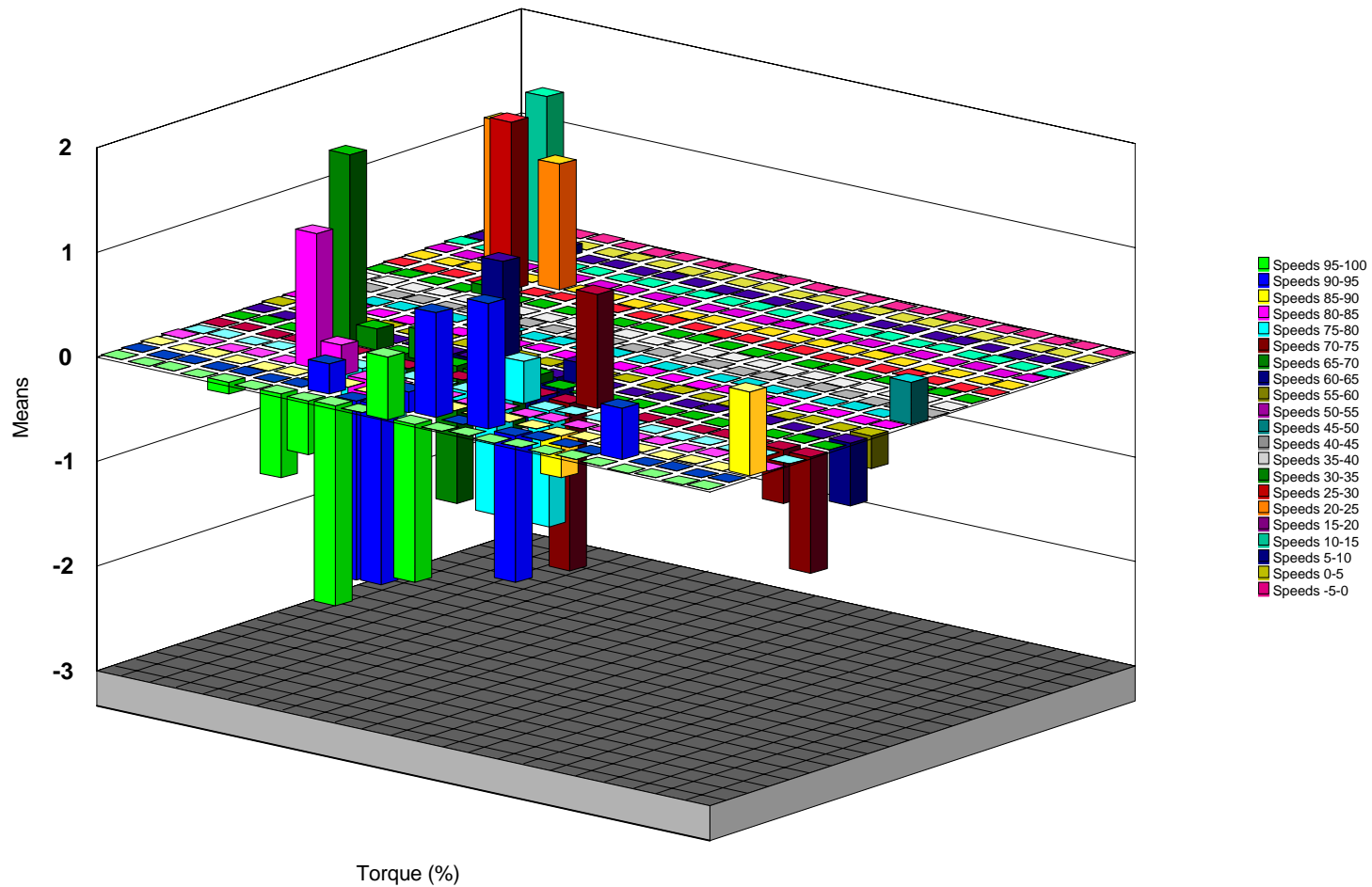
## SKID STEER LOADER TYPICAL 1--Torque Steady State Counts



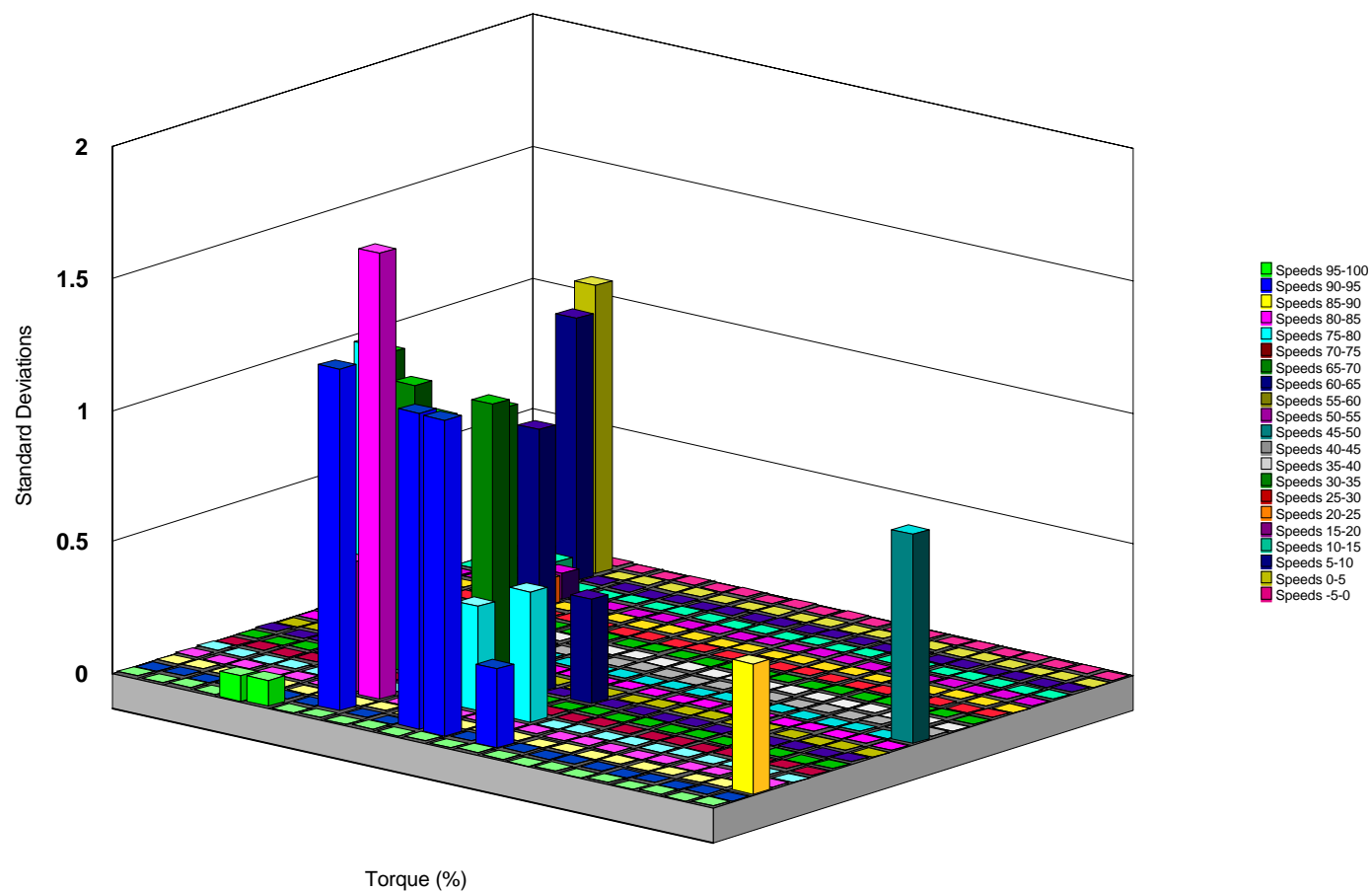
## SKID STEER LOADER TYPICAL 1--Torque Steady State Sums



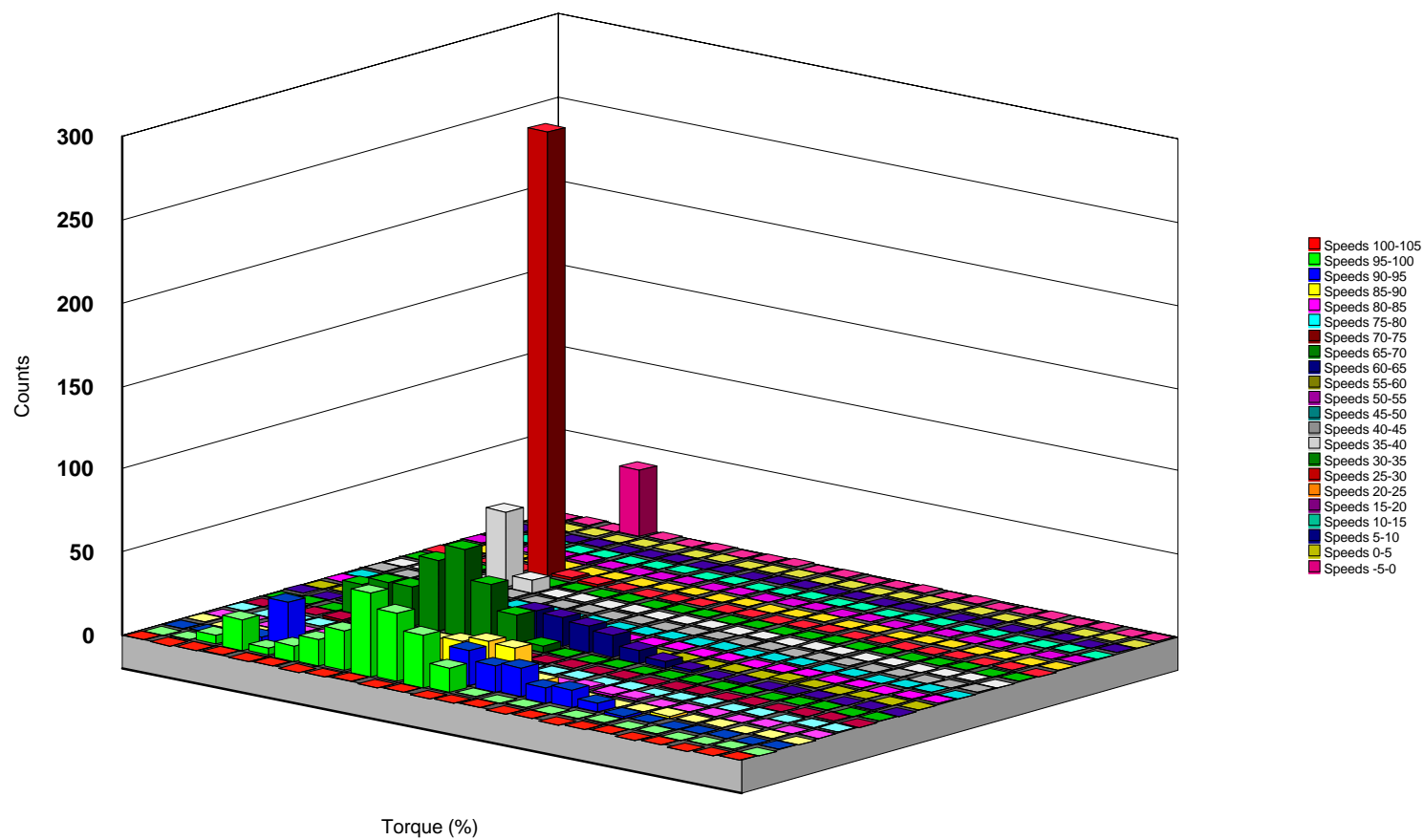
## SKID STEER LOADER TYPICAL 1--Torque Steady State Means



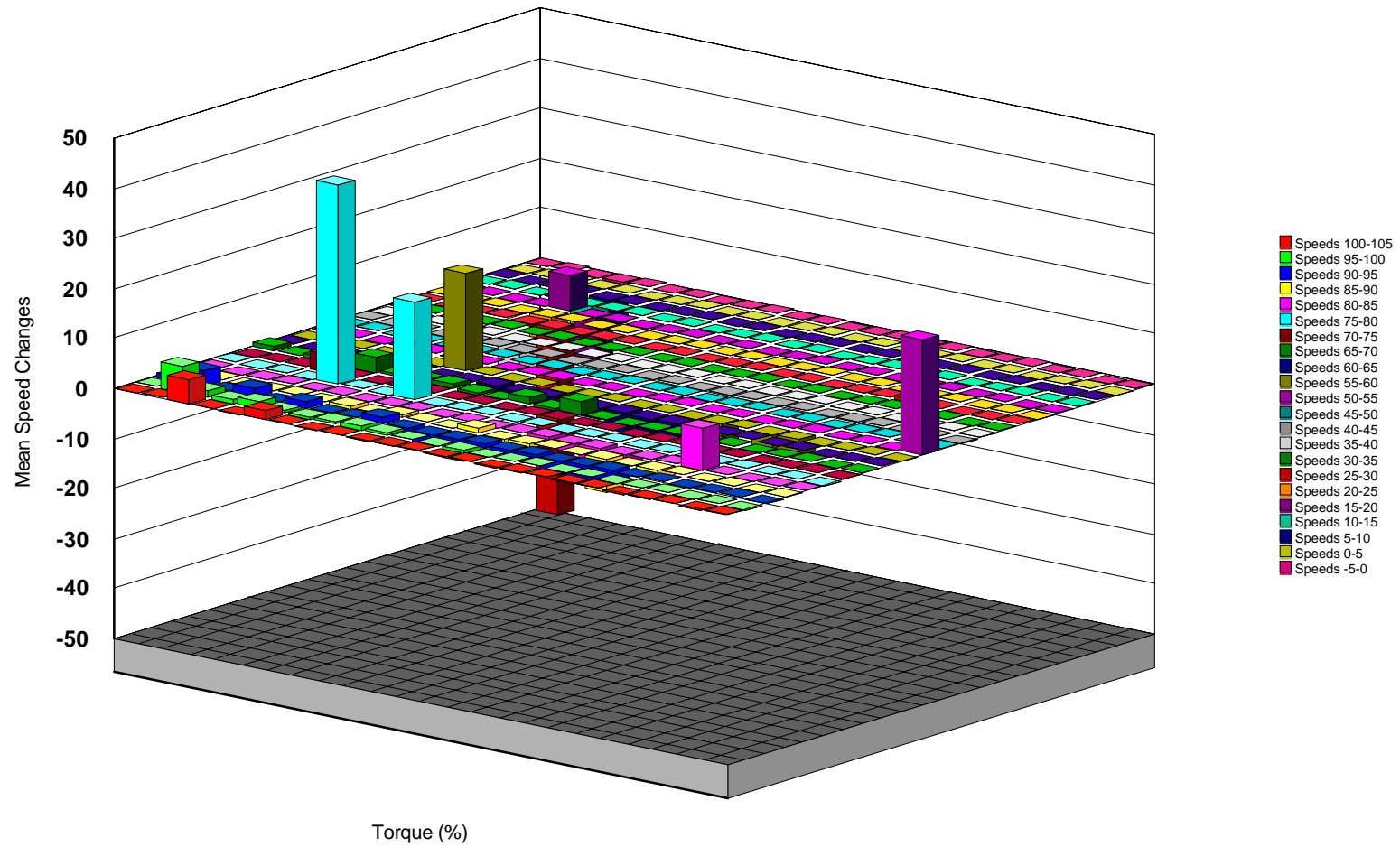
## SKID STEER LOADER TYPICAL 1--Torque Steady State Standard Deviations



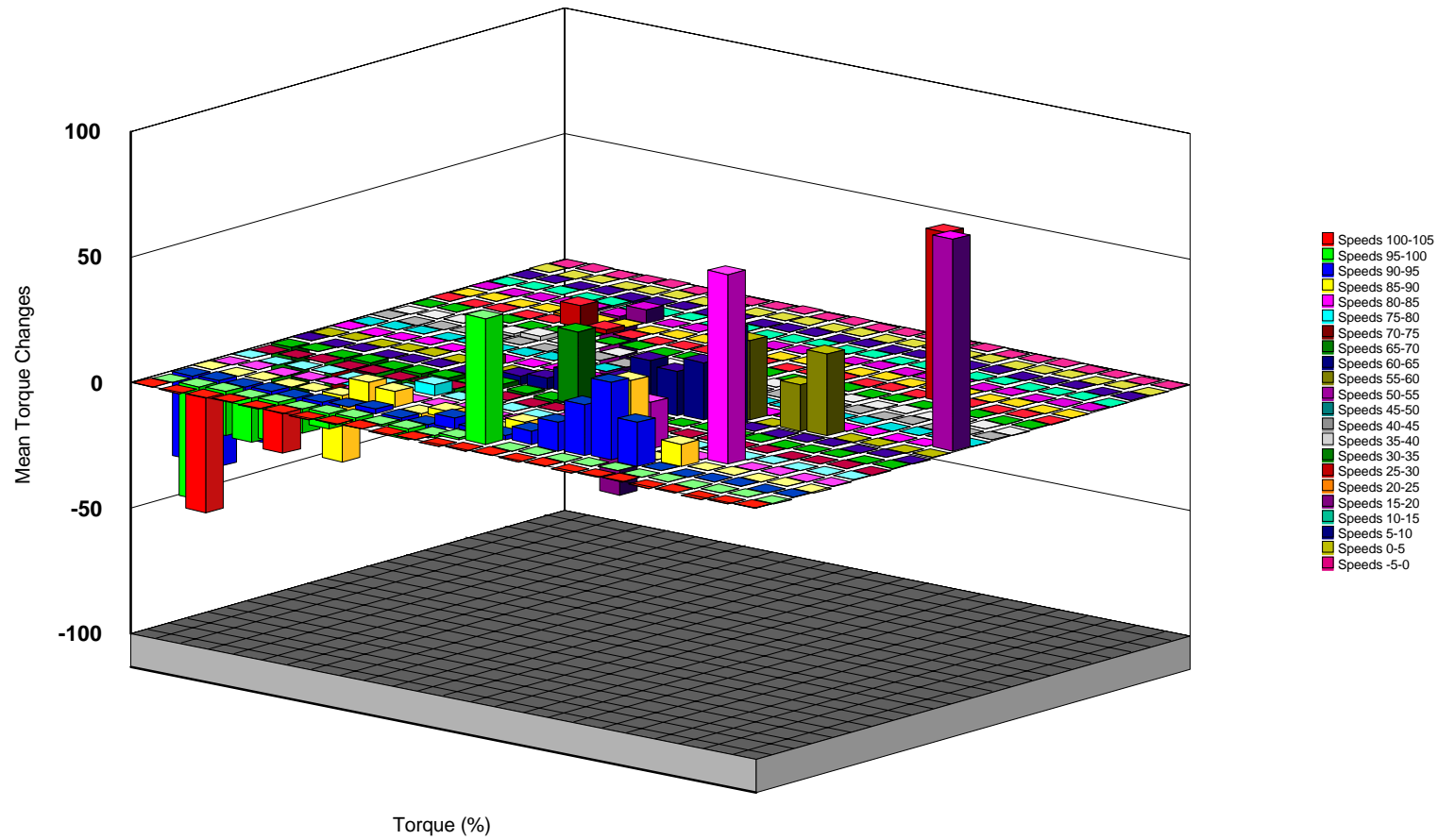
## SKID STEER LOADER TYPICAL 2--Counts



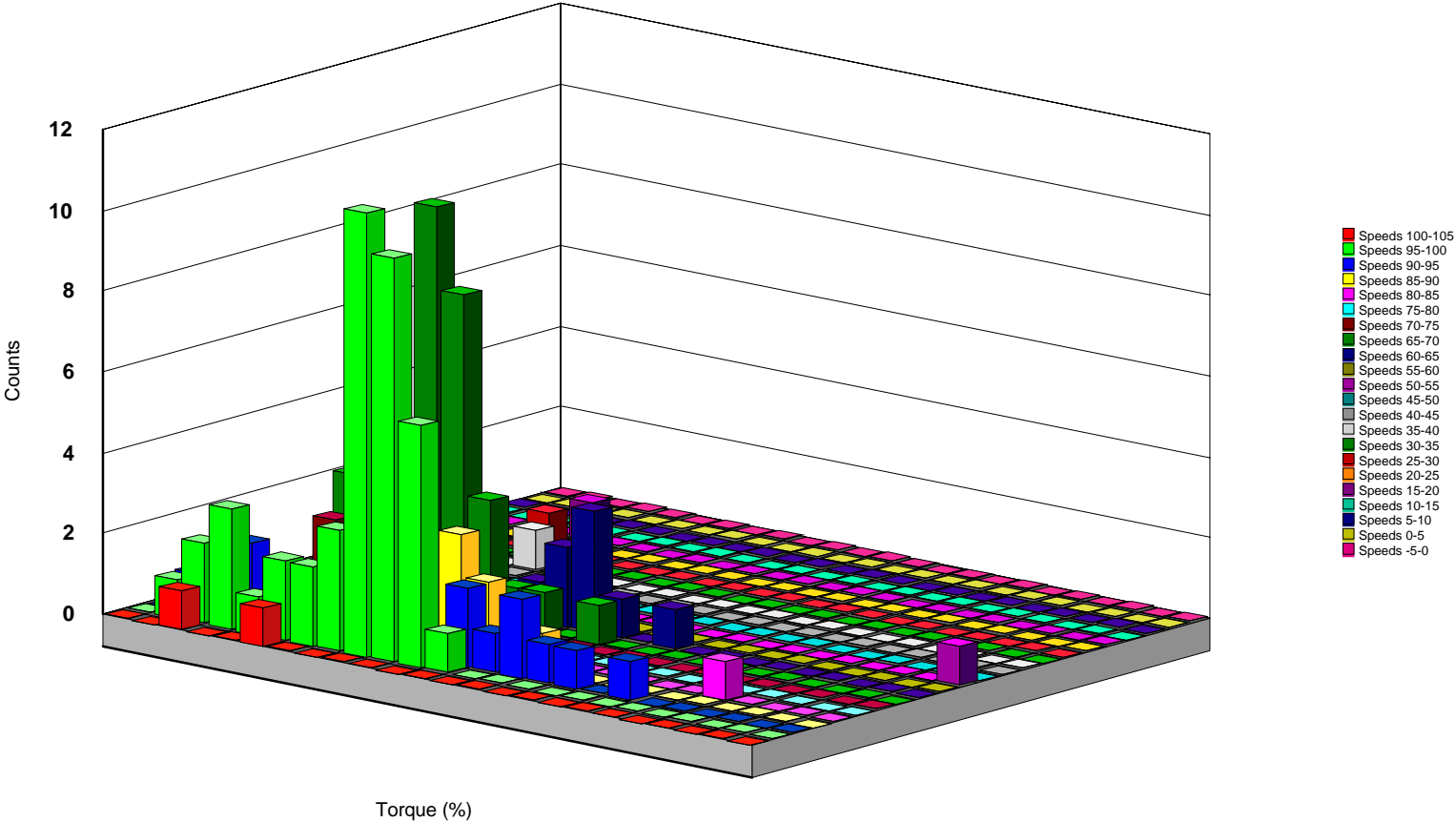
## SKID STEER LOADER TYPICAL 2--Mean Speed Changes



## SKID STEER LOADER TYPICAL 2--Mean Torque Changes

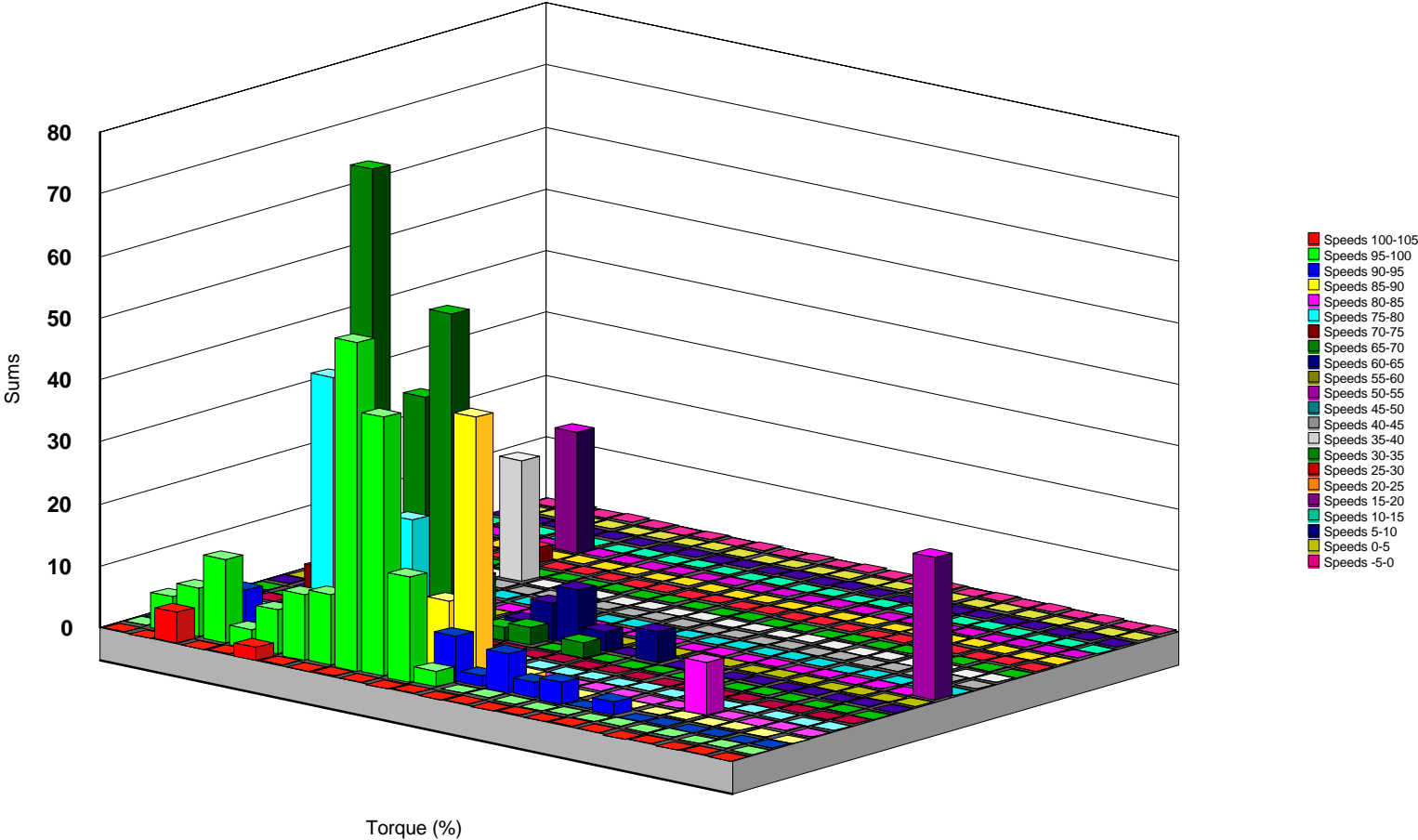


SKID STEER LOADER TYPICAL 2--Speed Acceleration Counts

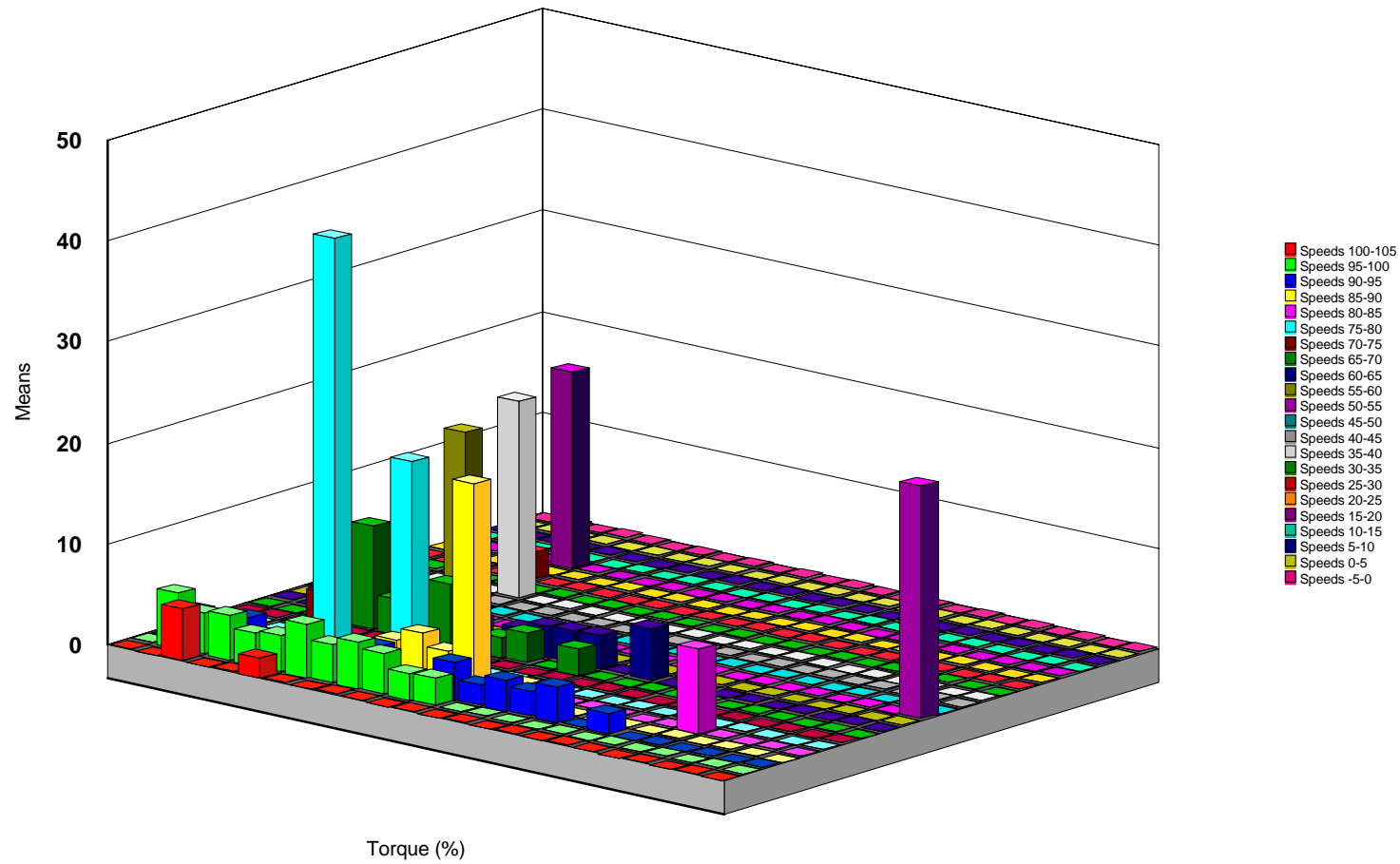




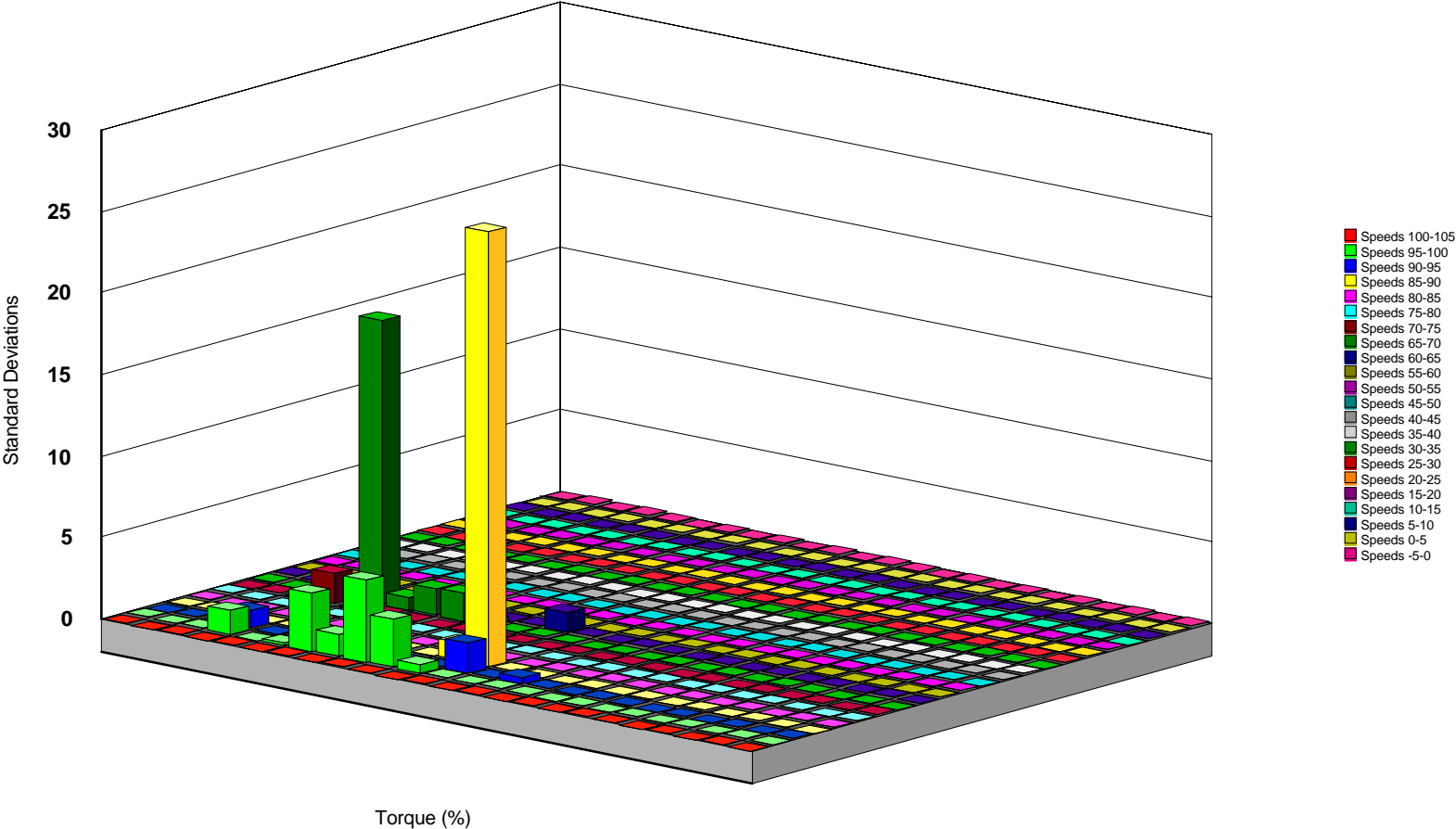
SKID STEER LOADER TYPICAL 2--Speed Acceleration Sums



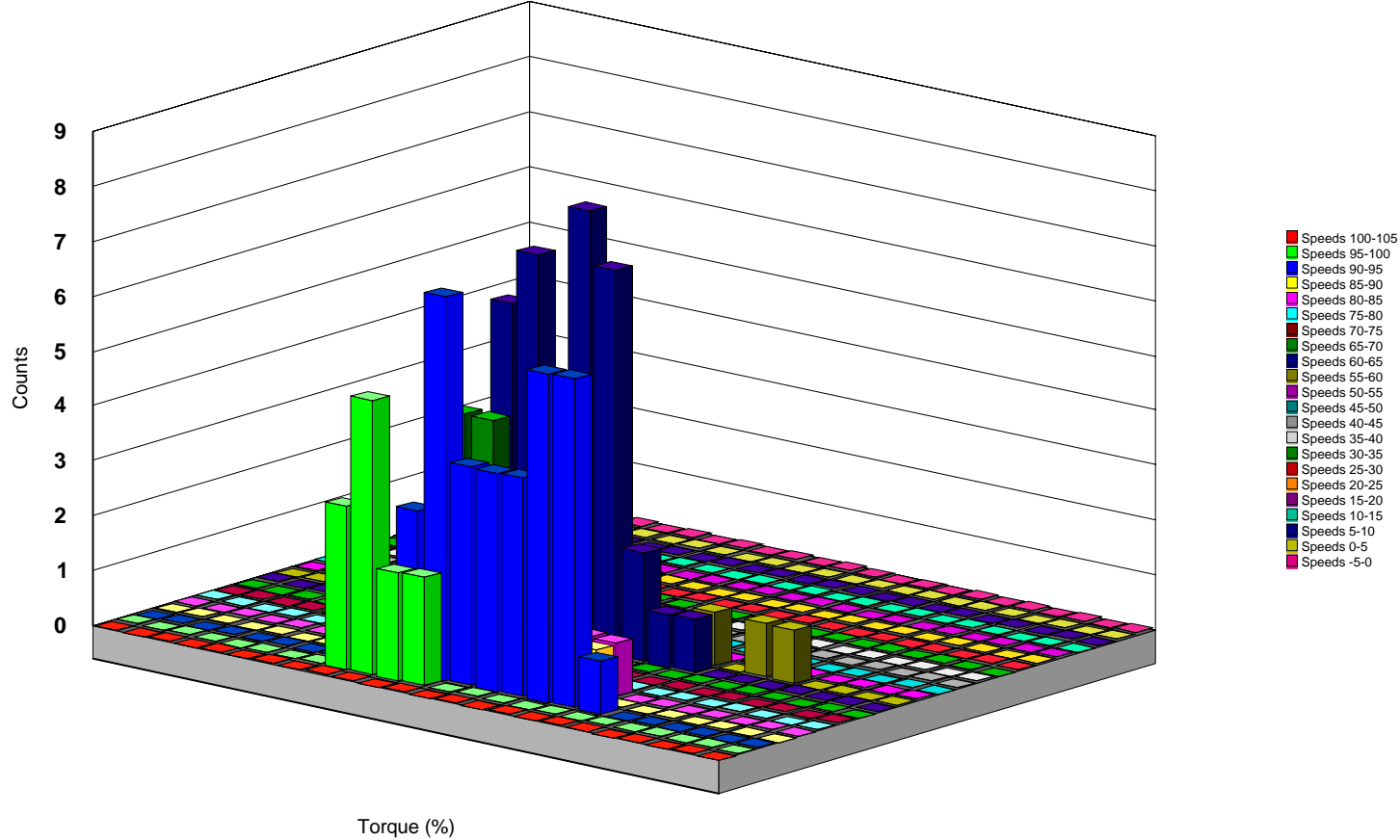
## SKID STEER LOADER TYPICAL 2--Speed Acceleration Means



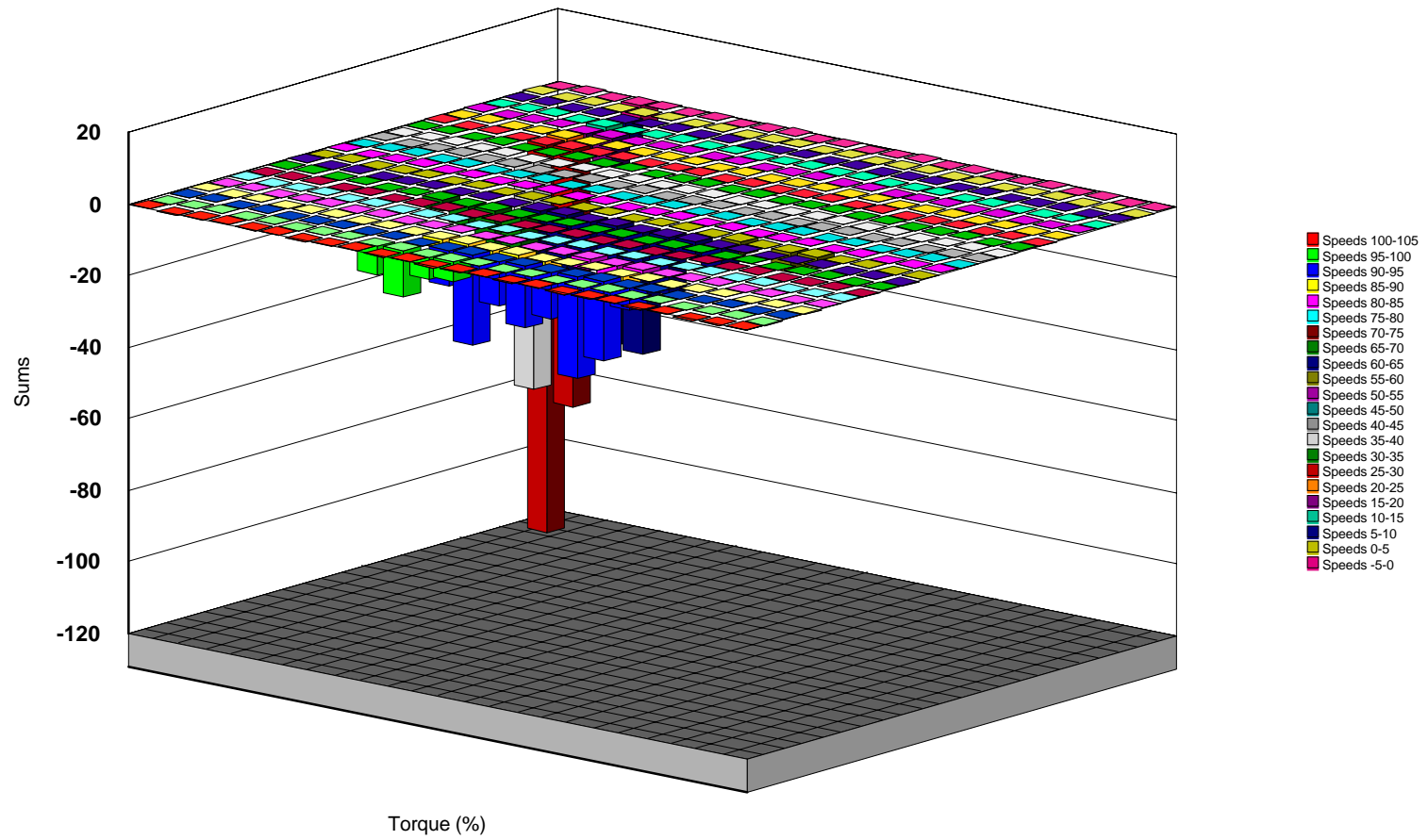
SKID STEER LOADER TYPICAL 2--Speed Acceleration Standard Deviations



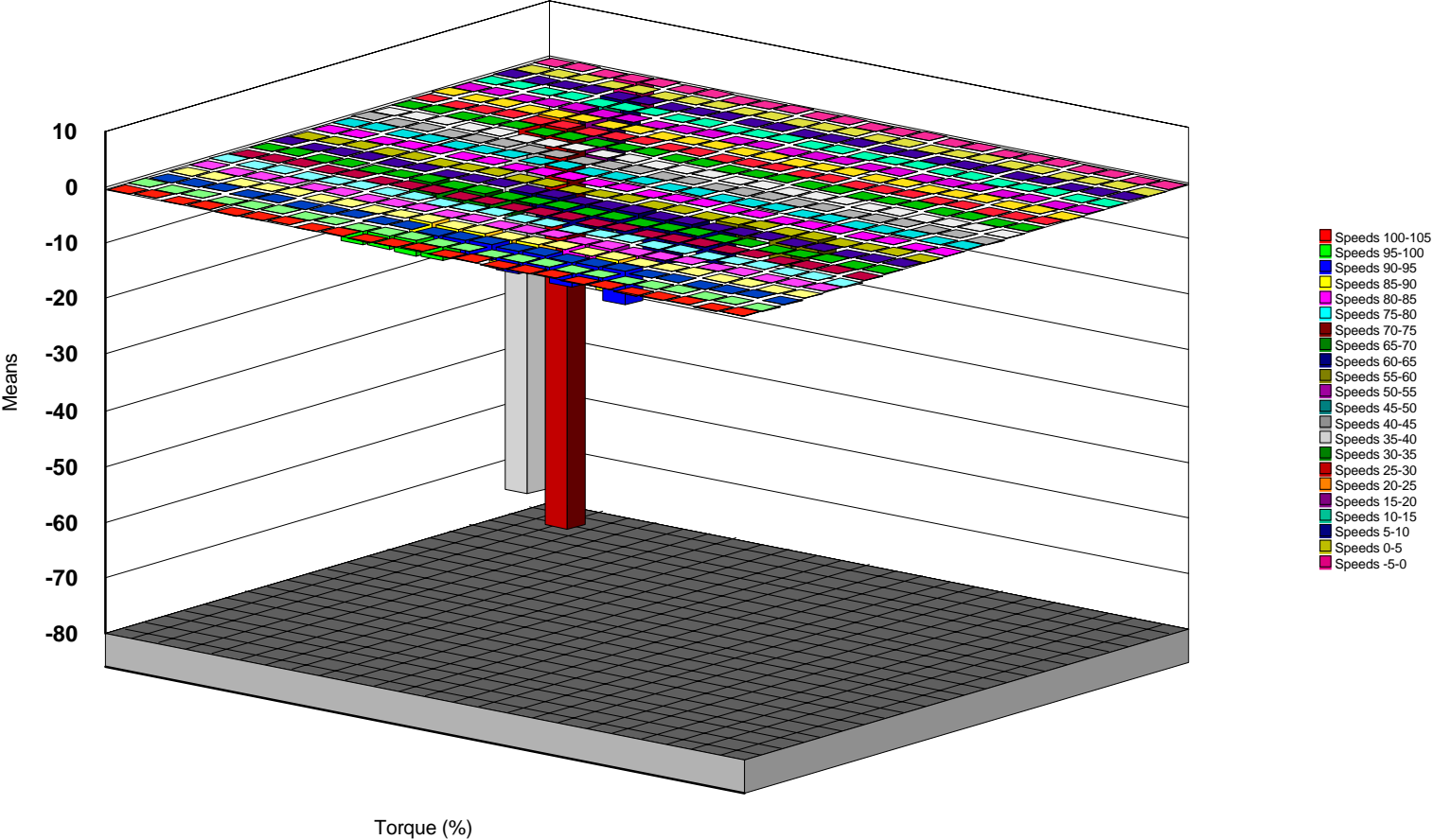
# SKID STEER LOADER TYPICAL 2--Speed Deceleration Counts



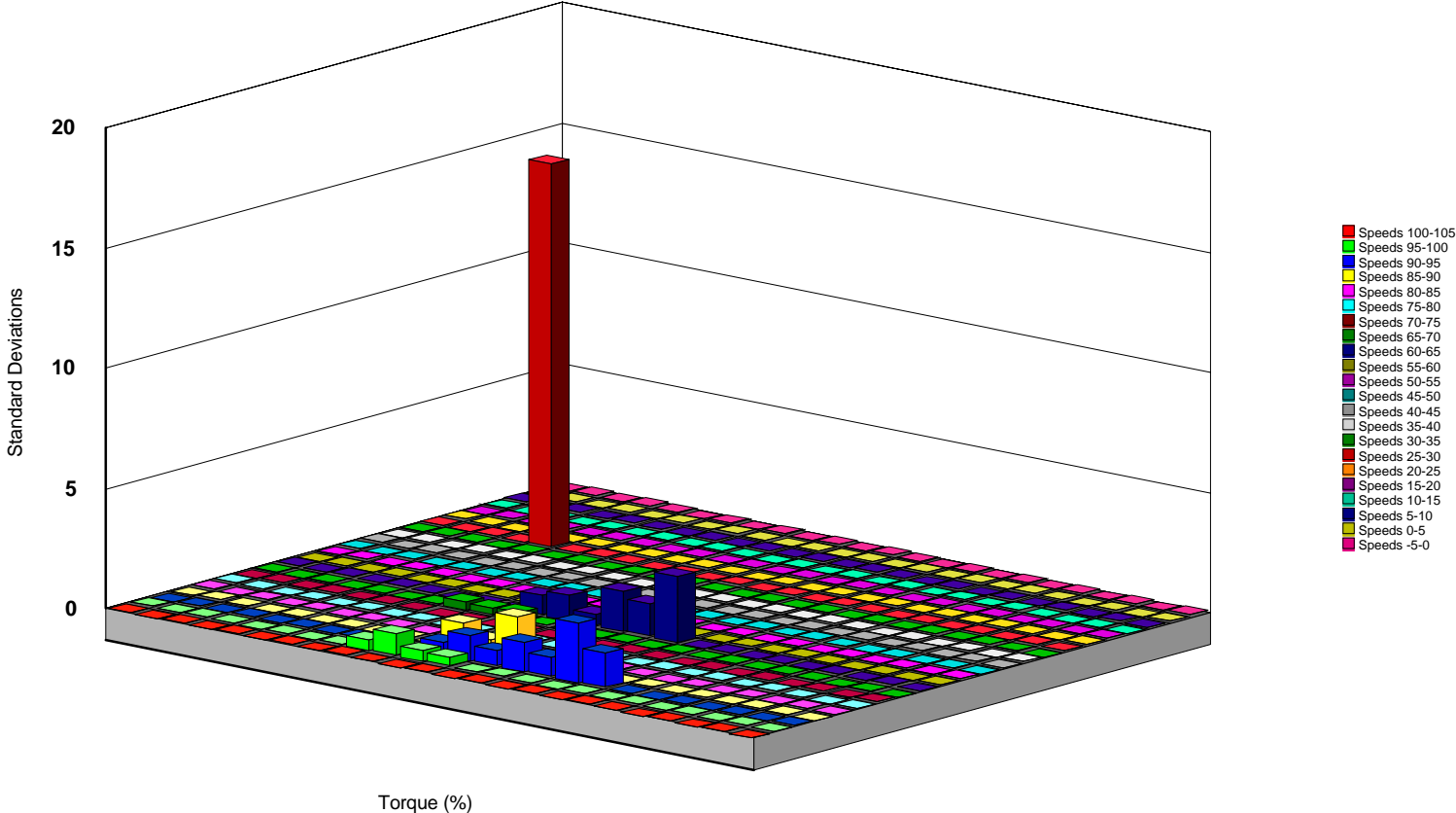
## SKID STEER LOADER TYPICAL 2--Speed Deceleration Sums



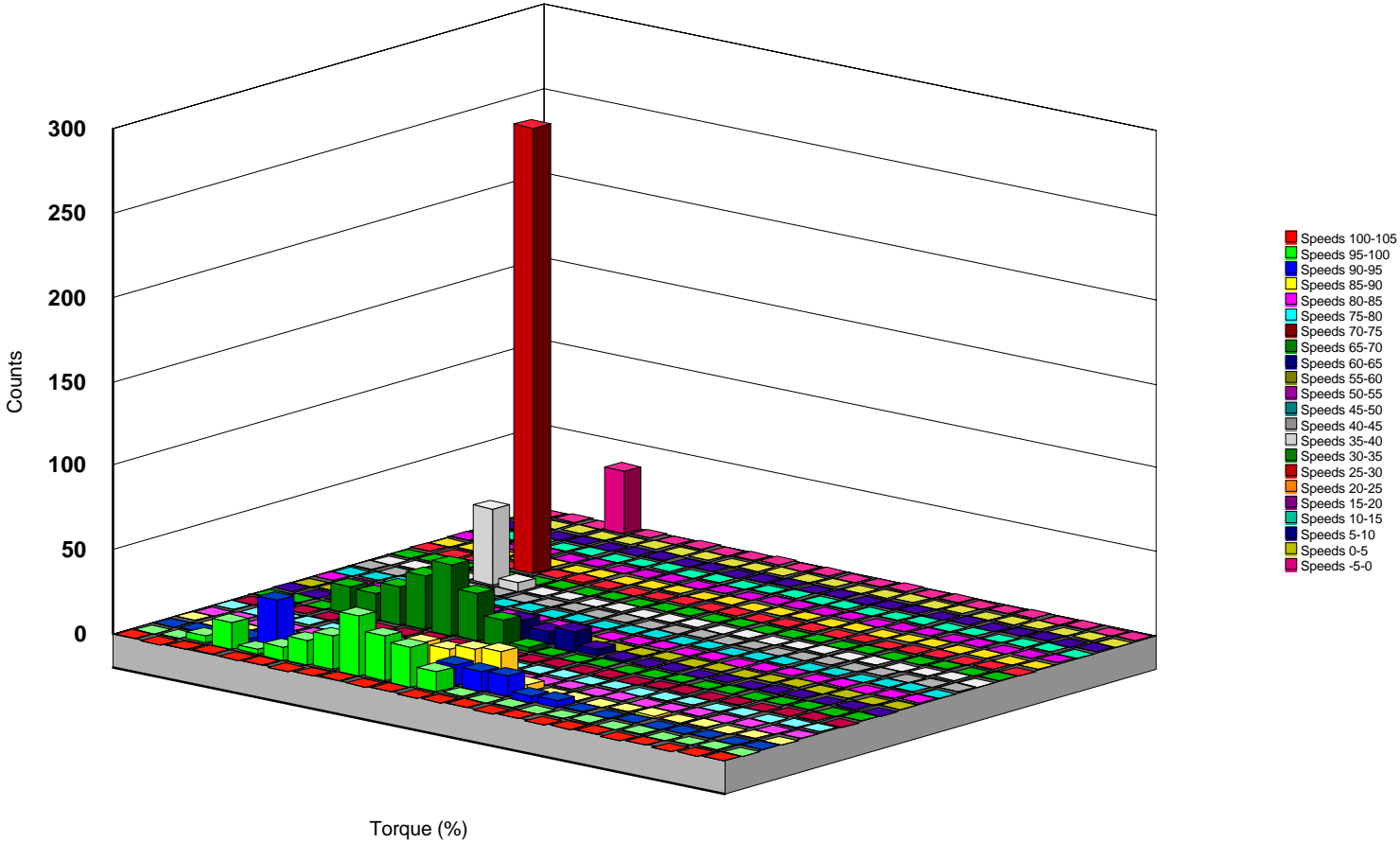
SKID STEER LOADER TYPICAL 2--Speed Deceleration Means



SKID STEER LOADER TYPICAL 2--Speed Deceleration Standard Deviations

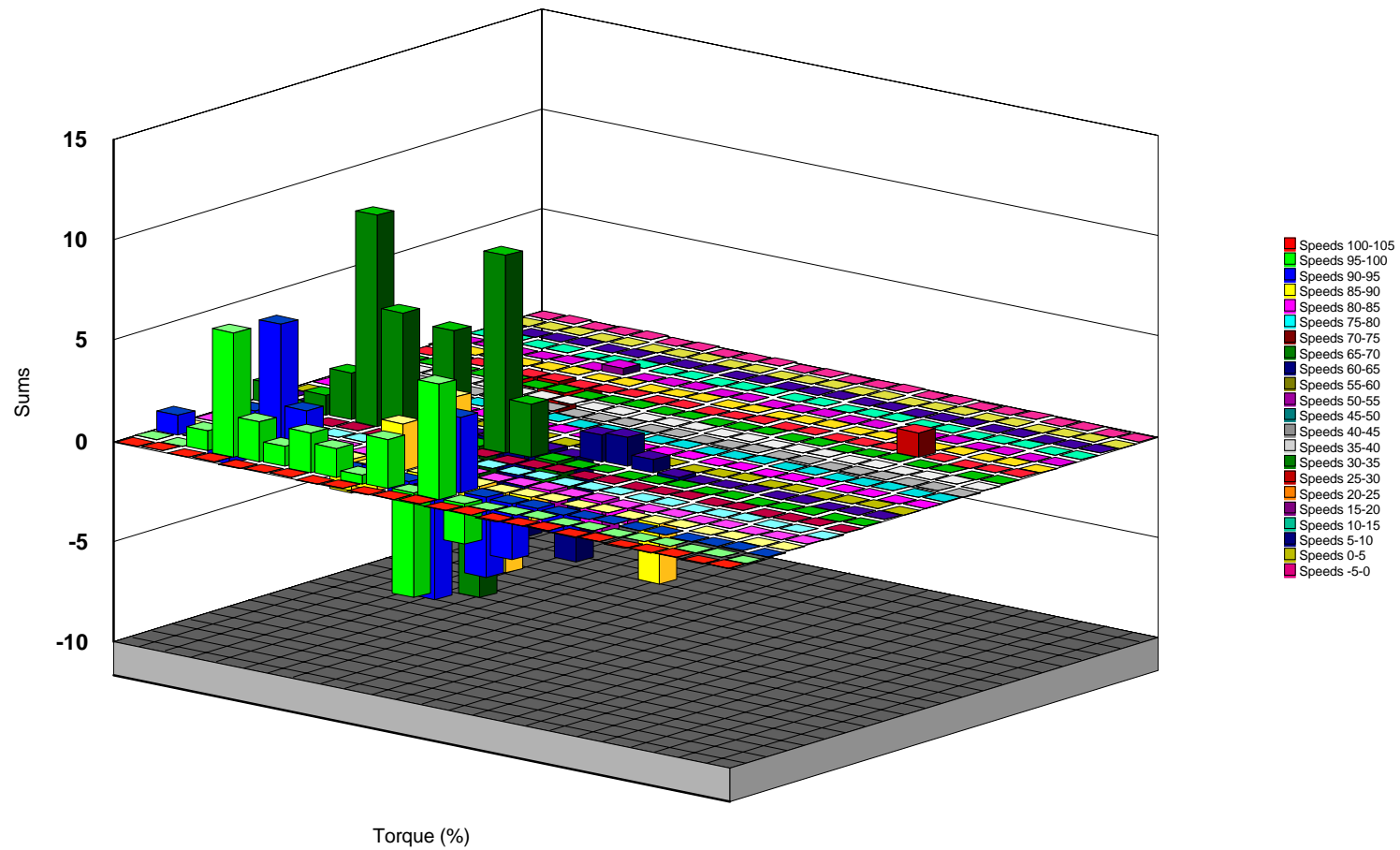


# SKID STEER LOADER TYPICAL 2--Speed Steady State Counts

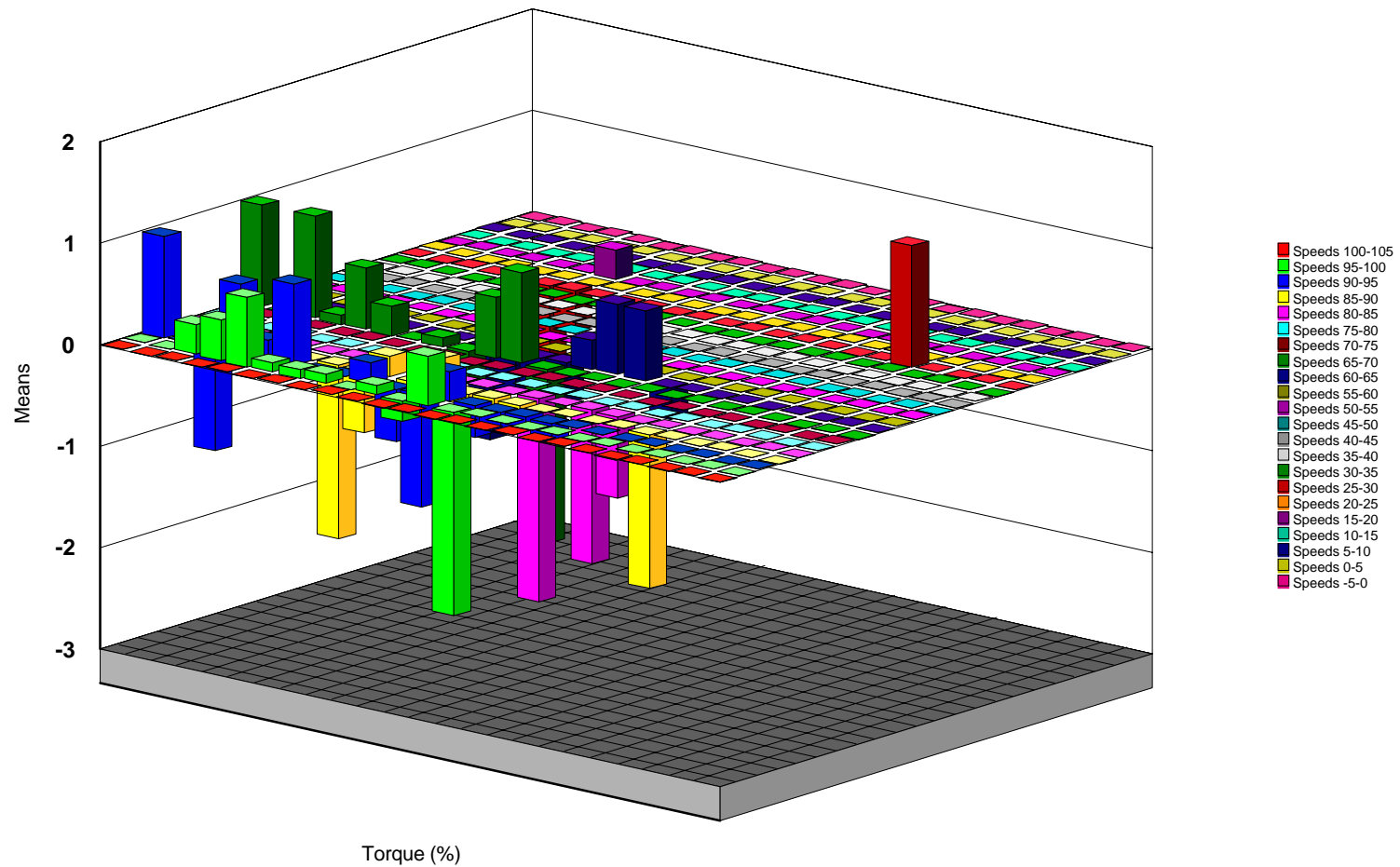




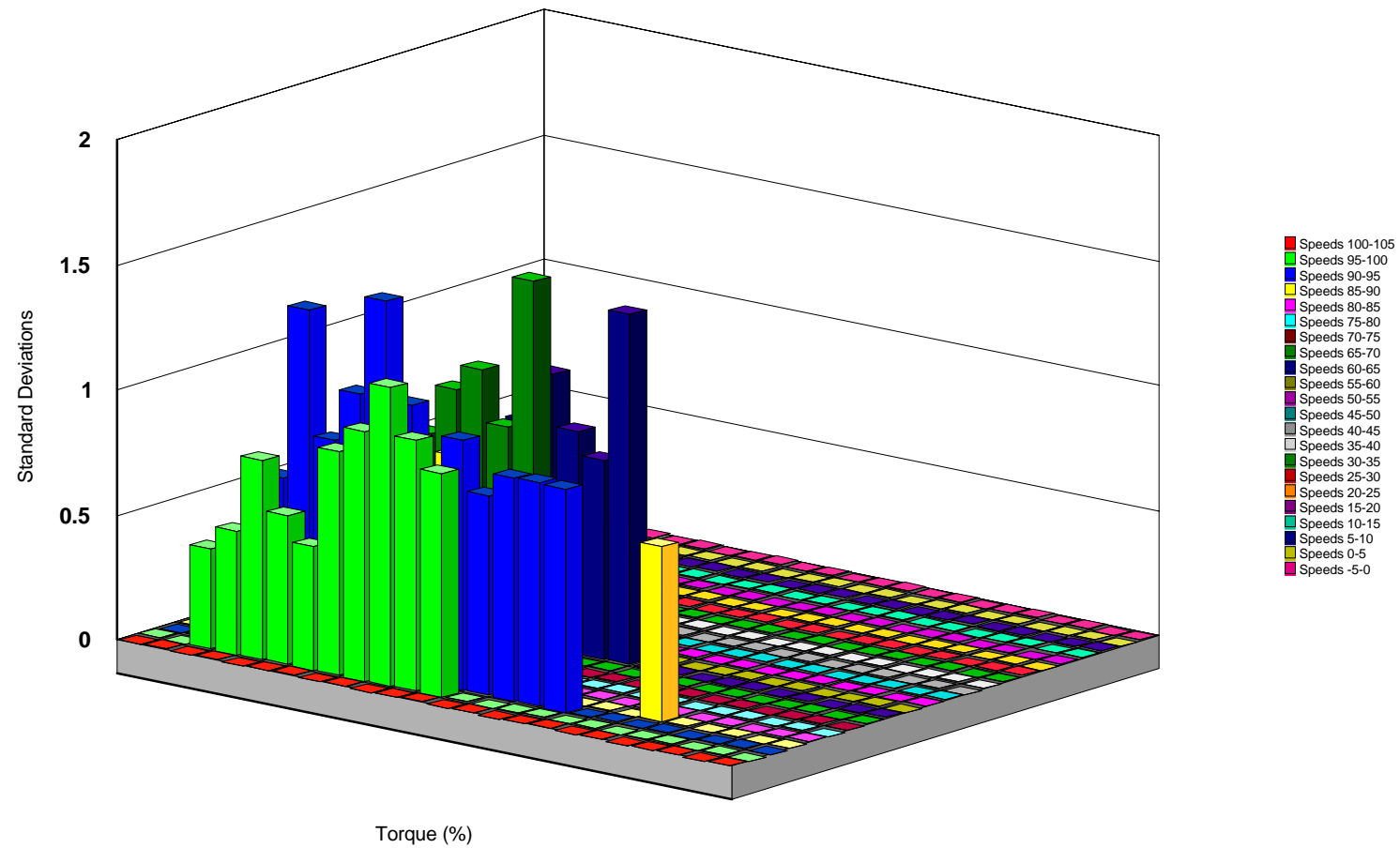
## SKID STEER LOADER TYPICAL 2--Speed Steady State Sums



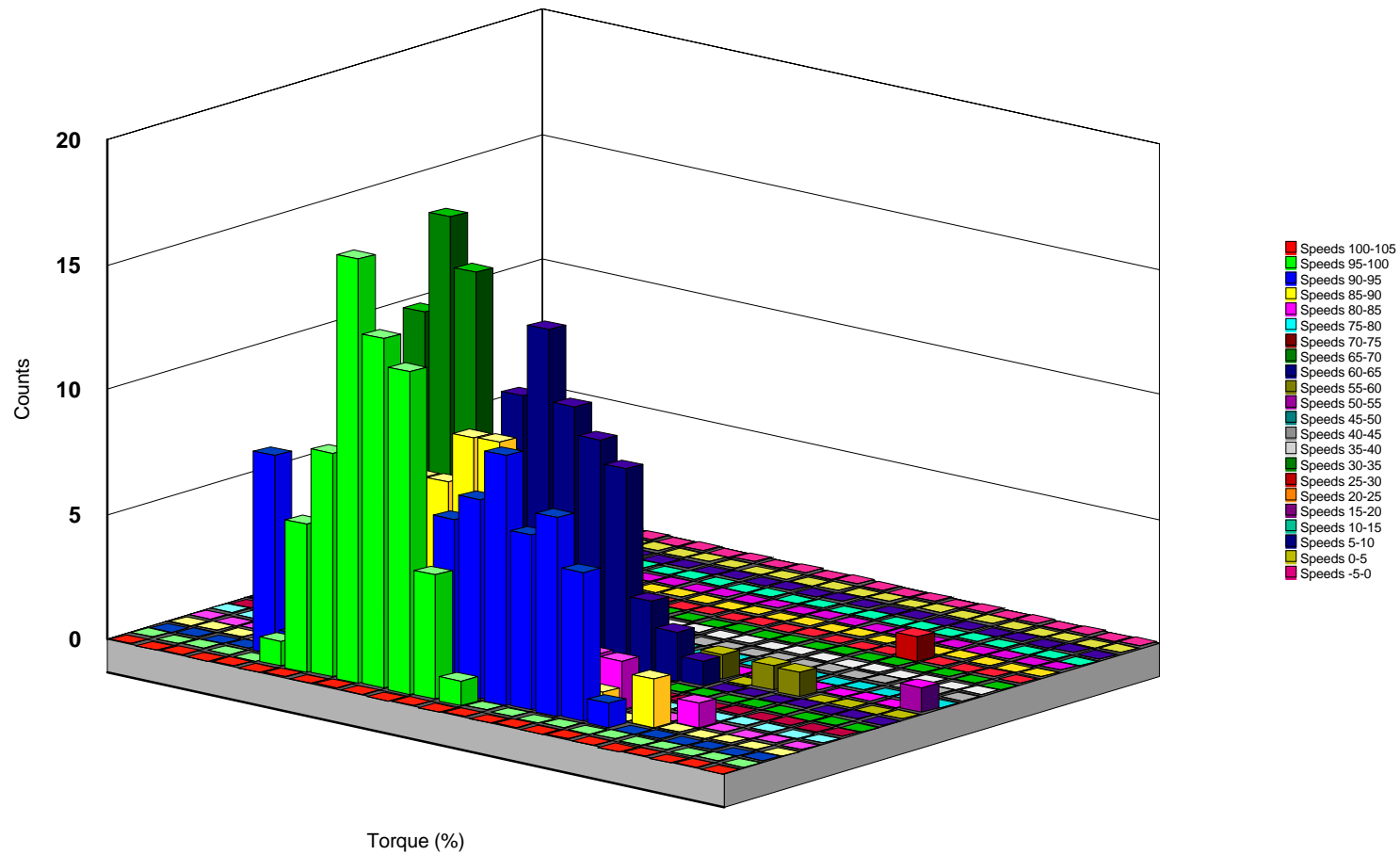
## SKID STEER LOADER TYPICAL 2--Speed Steady State Means



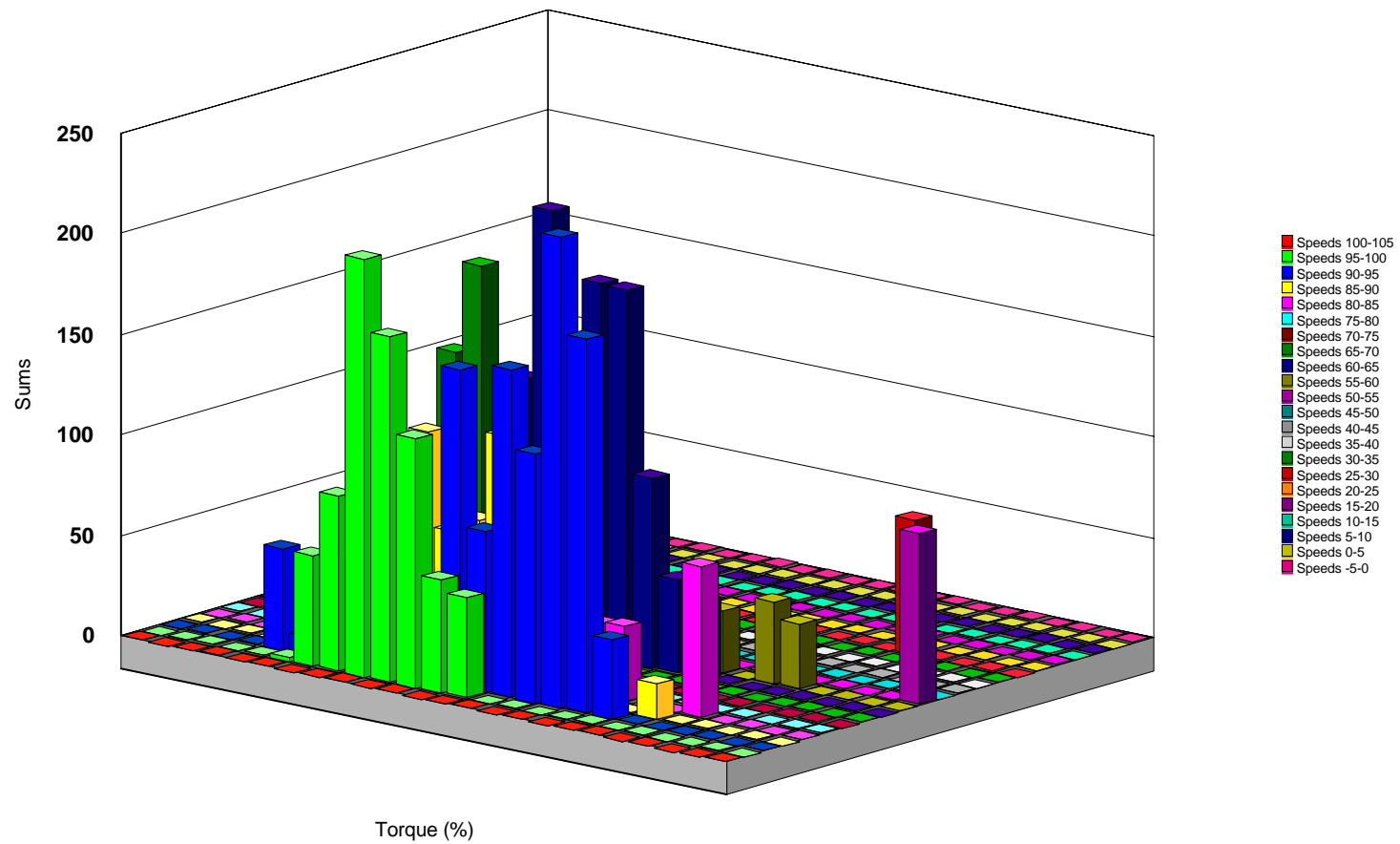
## SKID STEER LOADER TYPICAL 2--Speed Steady State Standard Deviations



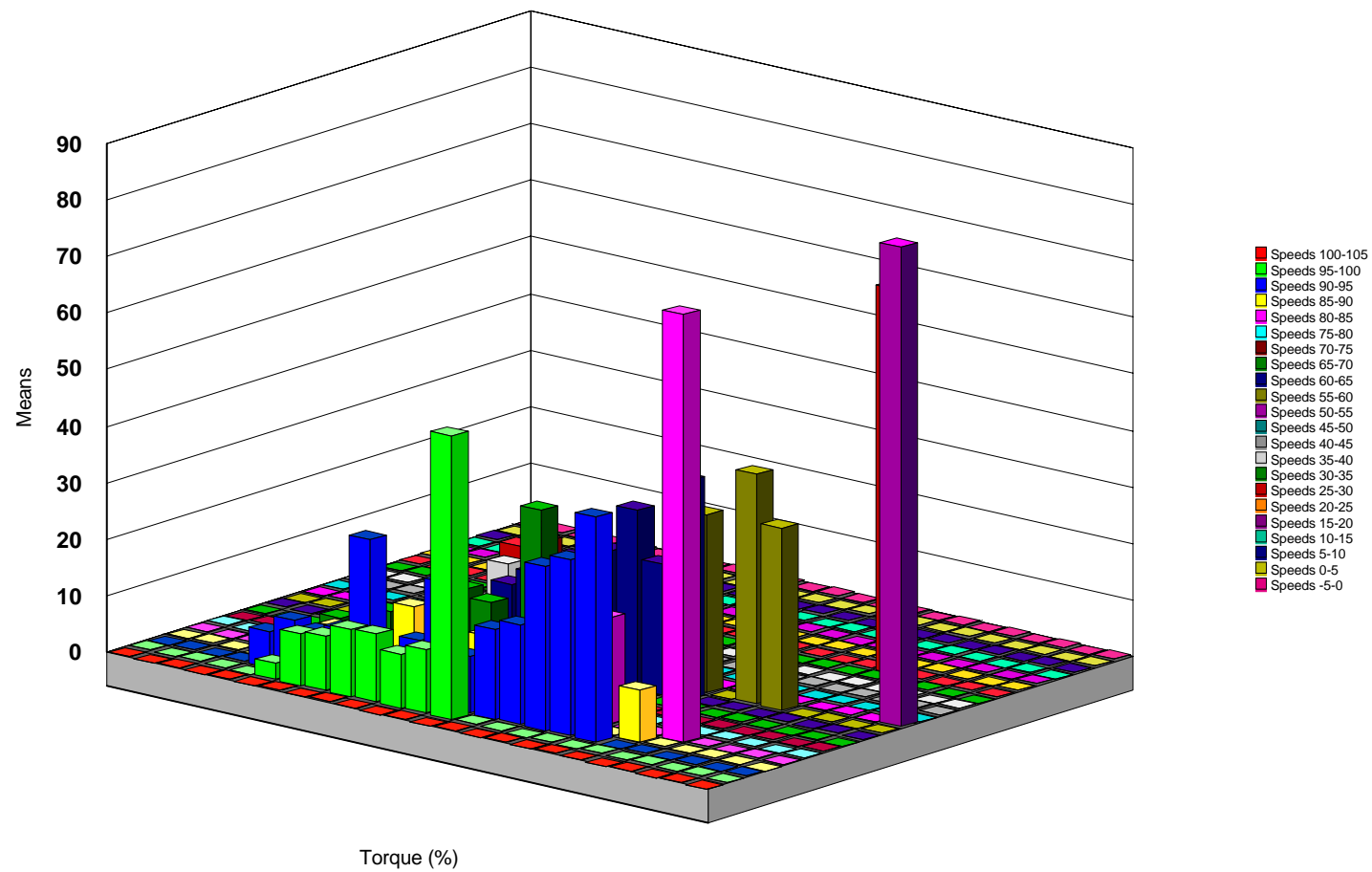
## SKID STEER LOADER TYPICAL 2--Torque Acceleration Counts



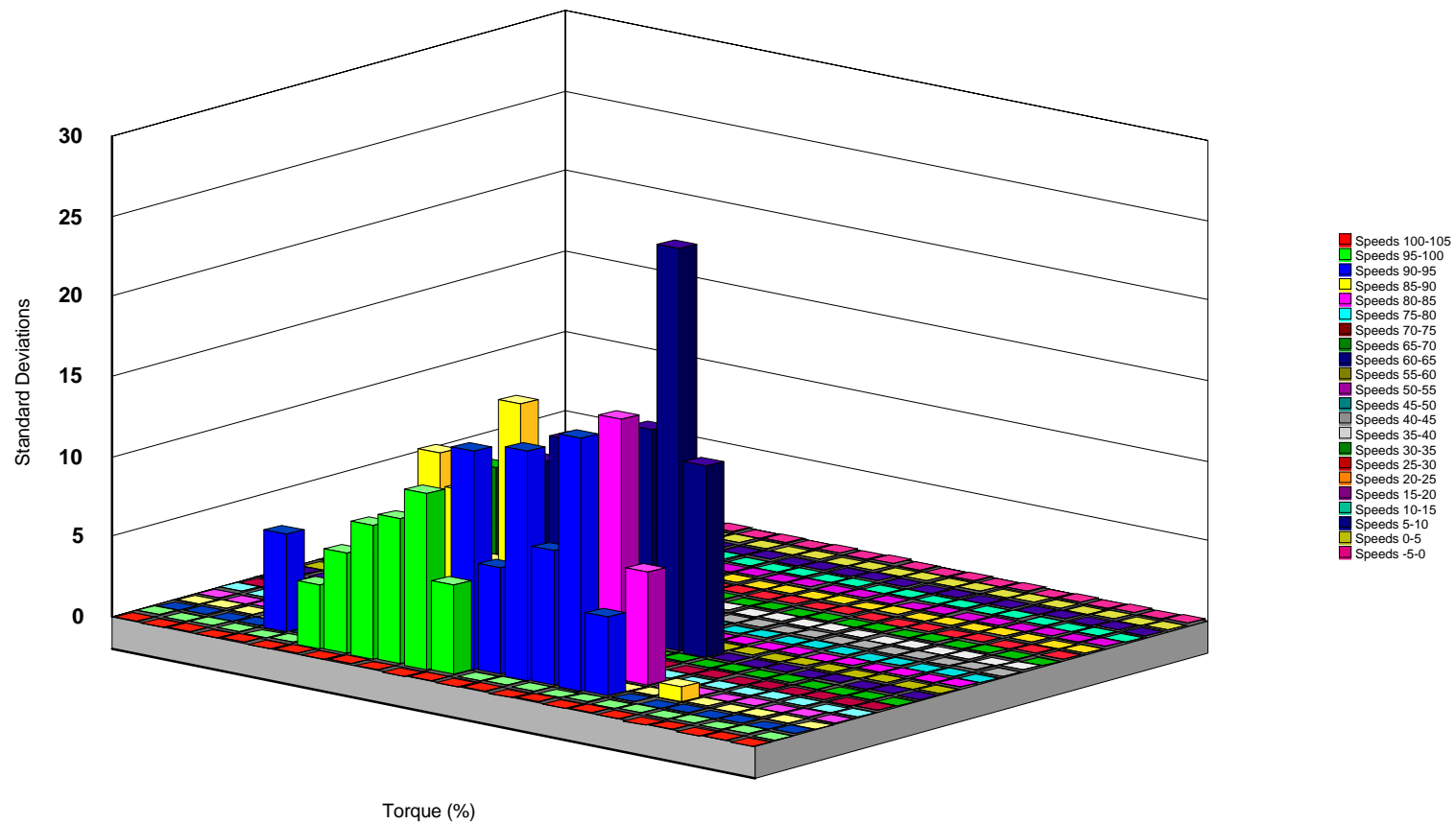
## SKID STEER LOADER TYPICAL 2--Torque Acceleration Sums



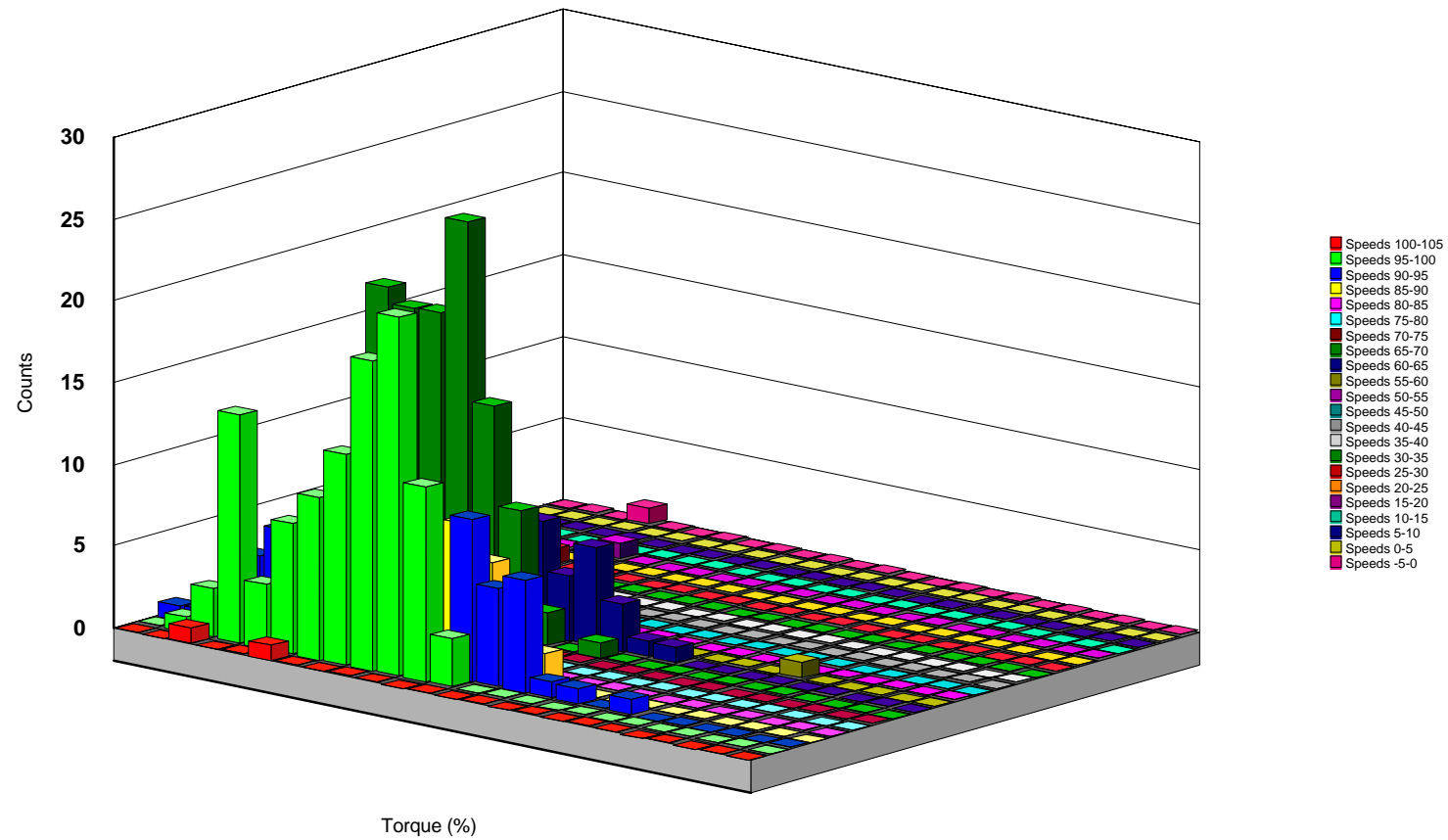
## SKID STEER LOADER TYPICAL 2--Torque Acceleration Means



## SKID STEER LOADER TYPICAL 2--Torque Acceleration Standard Deviations

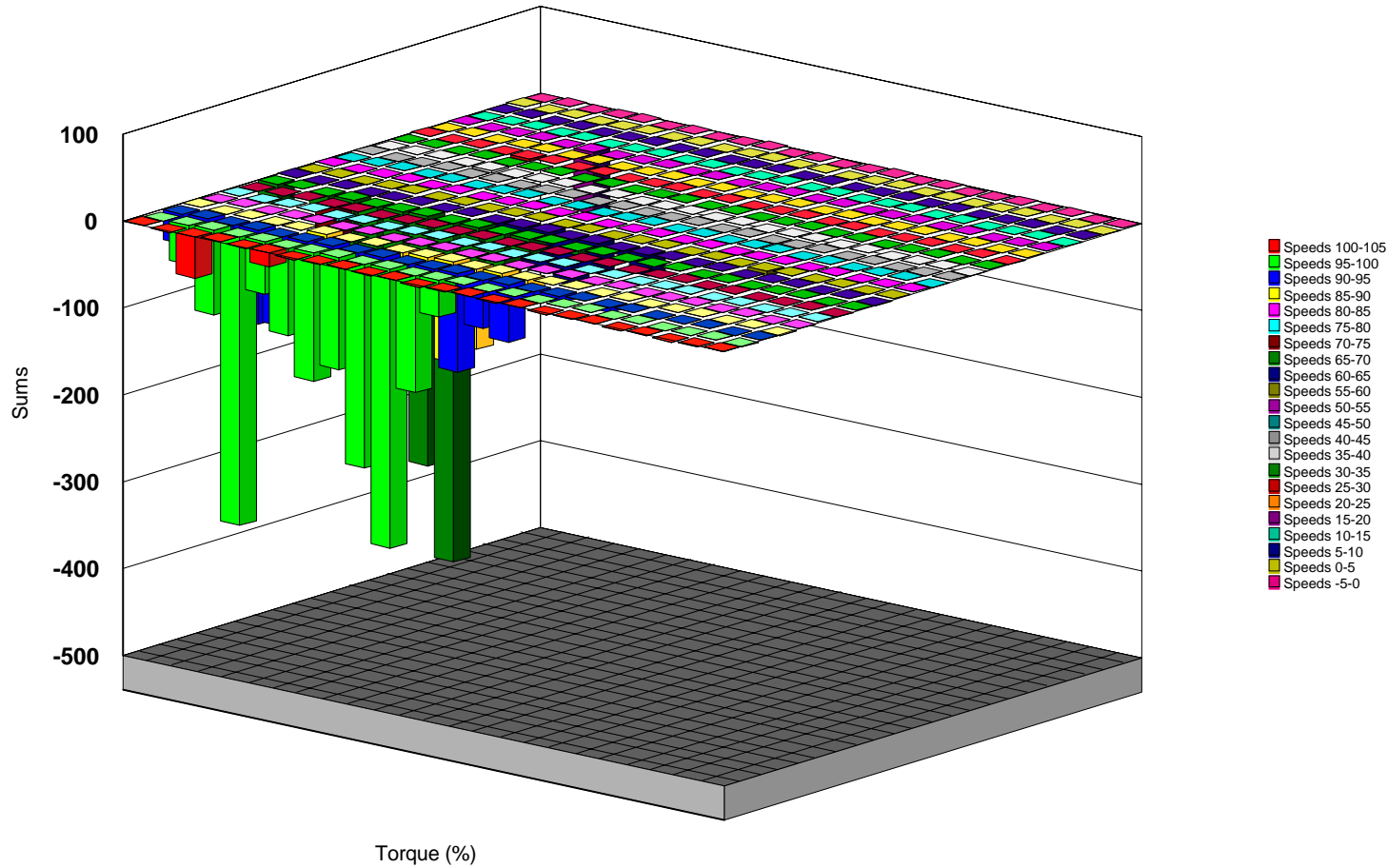


## SKID STEER LOADER TYPICAL 2--Torque Deceleration Counts

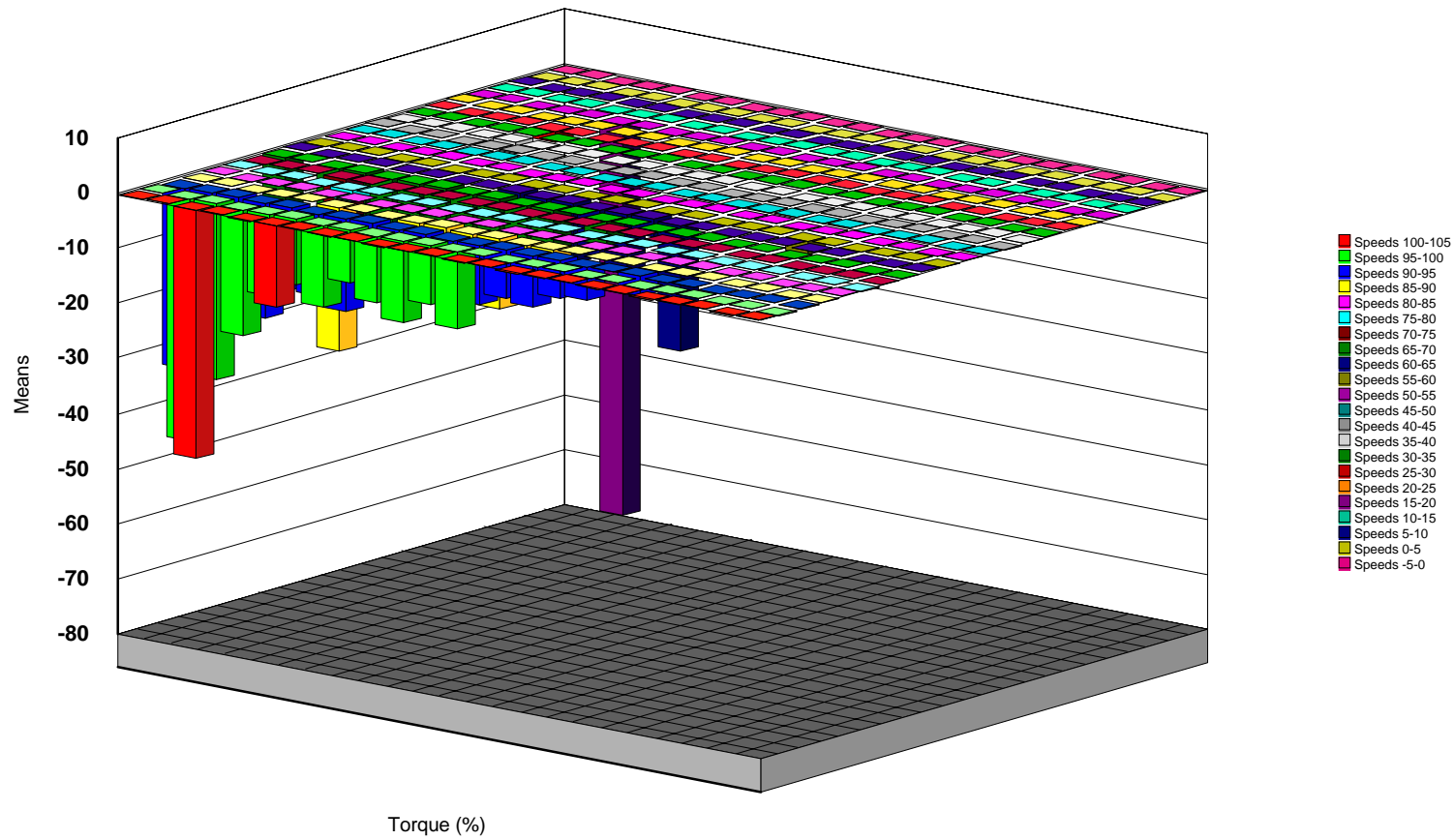




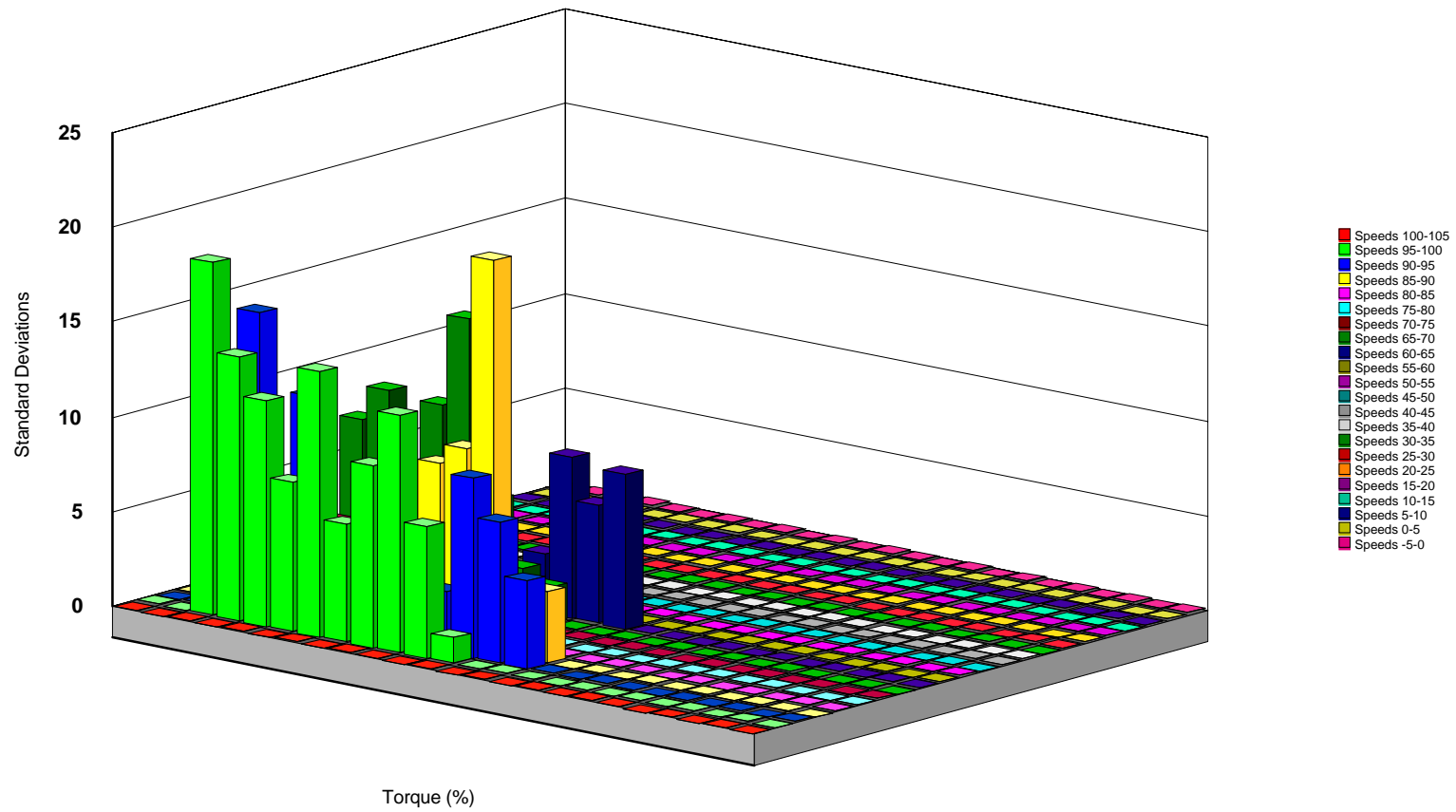
SKID STEER LOADER TYPICAL 2--Torque Deceleration Sums



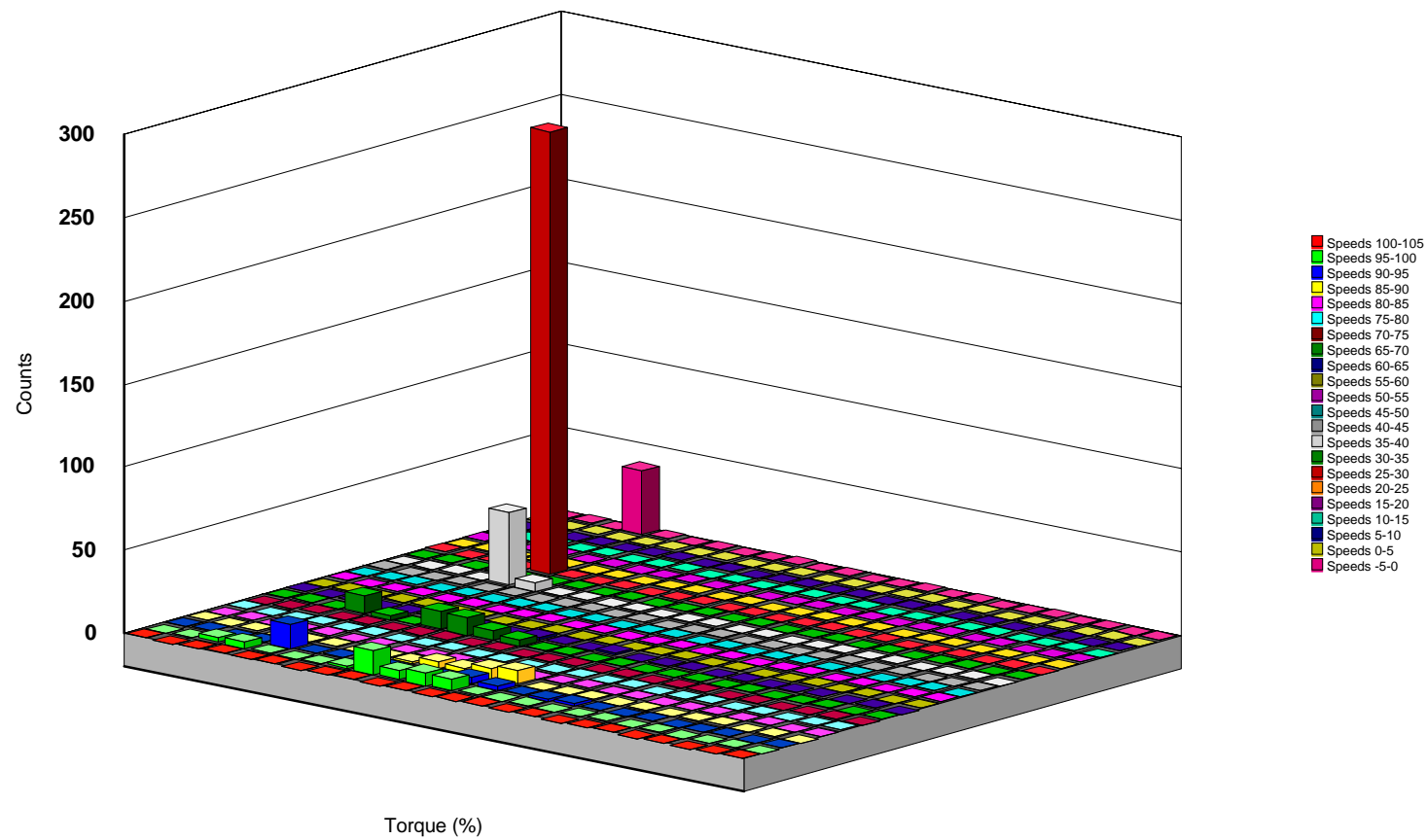
## SKID STEER LOADER TYPICAL 2--Torque Deceleration Means



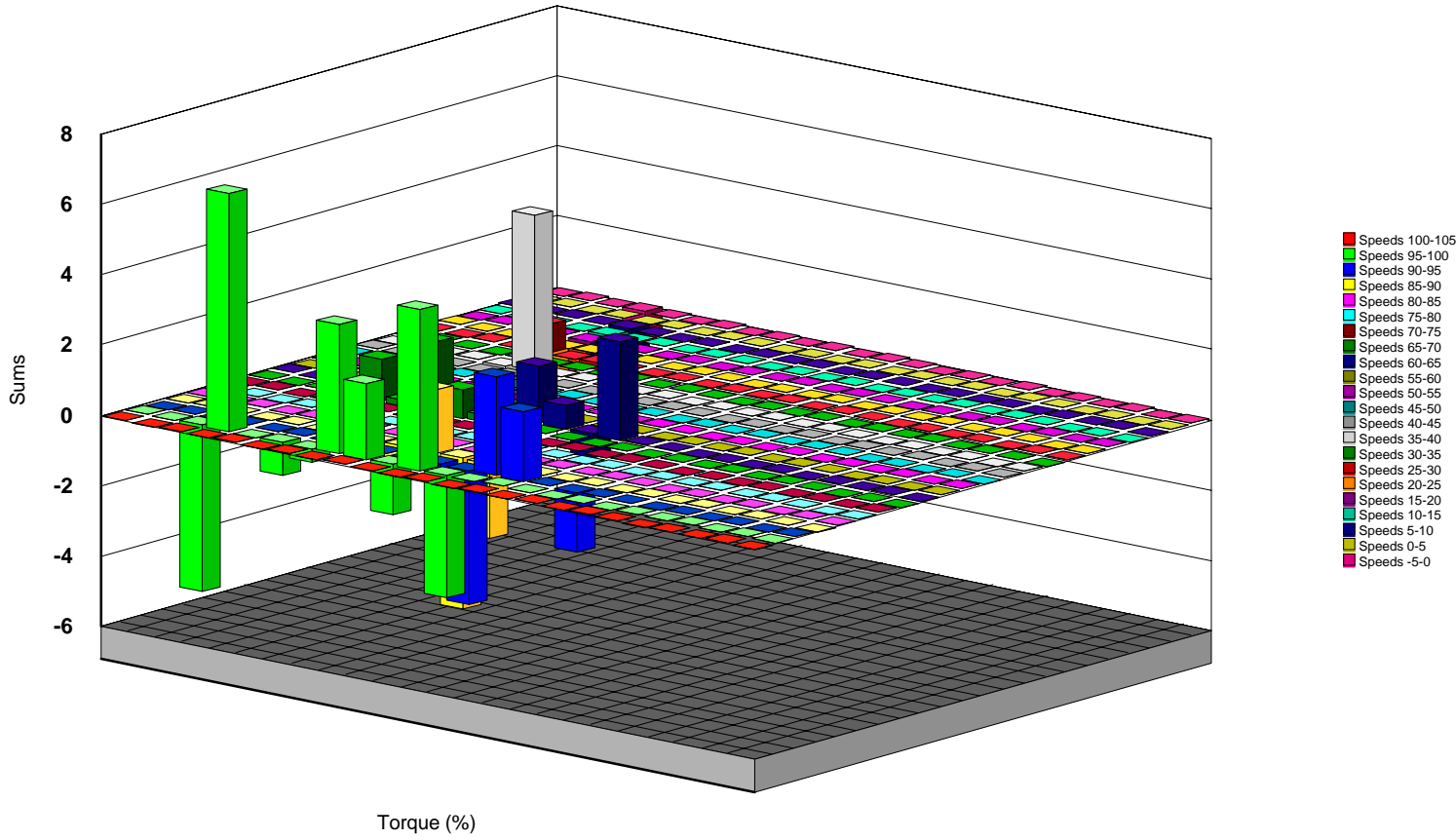
## SKID STEER LOADER TYPICAL 2--Torque Deceleration Standard Deviations



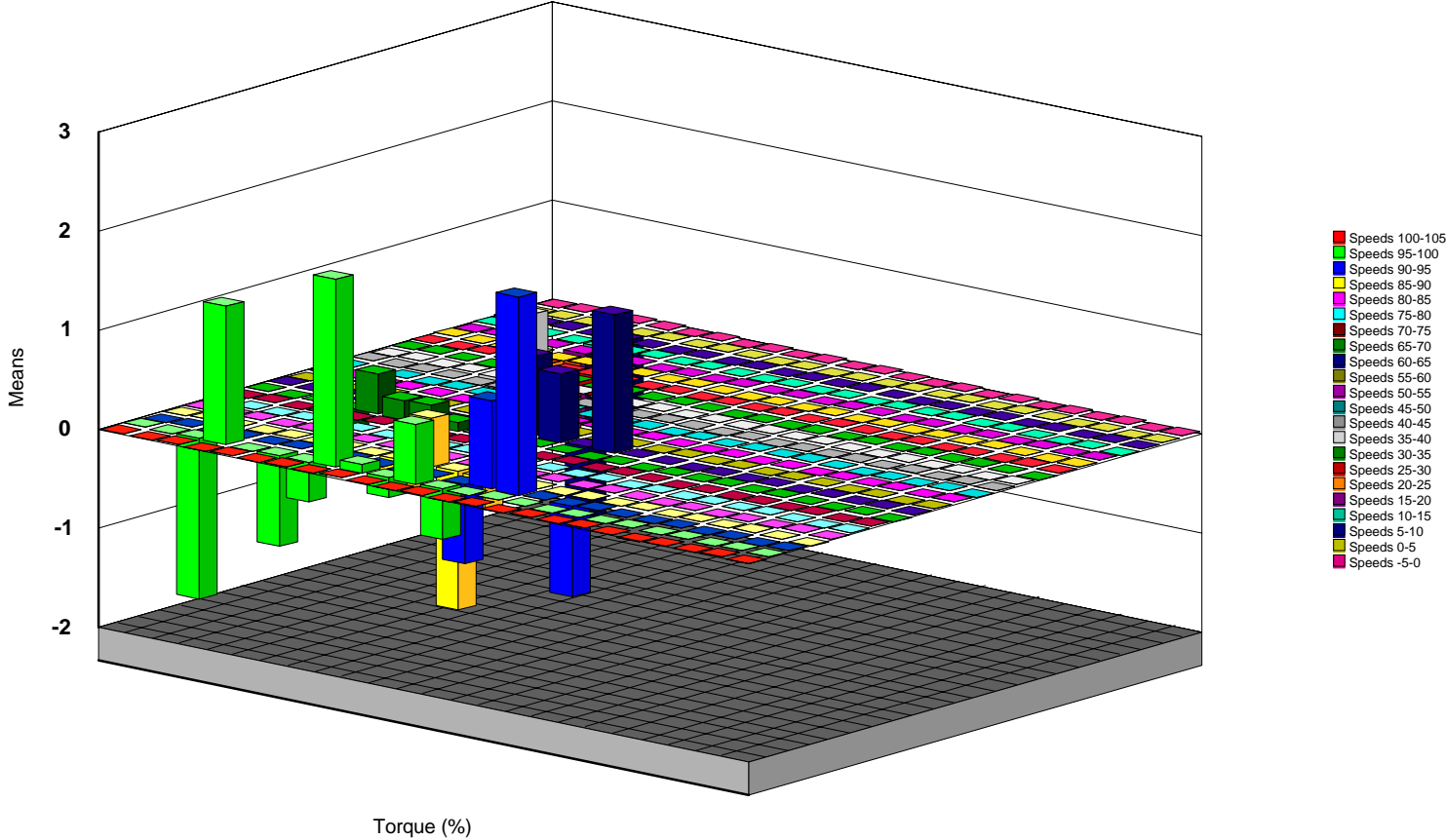
## SKID STEER LOADER TYPICAL 2--Torque Steady State Counts



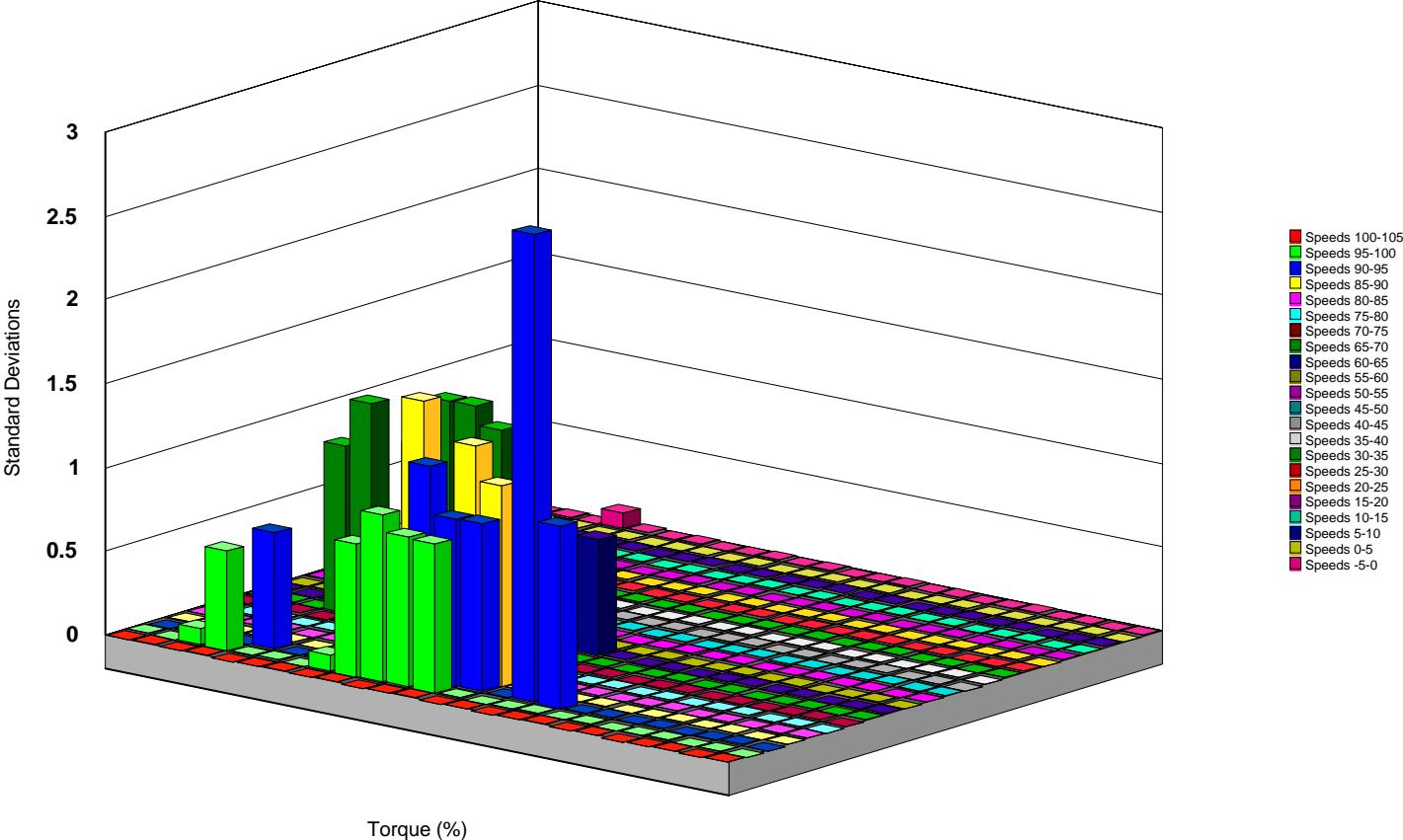
# SKID STEER LOADER TYPICAL 2--Torque Steady State Sums



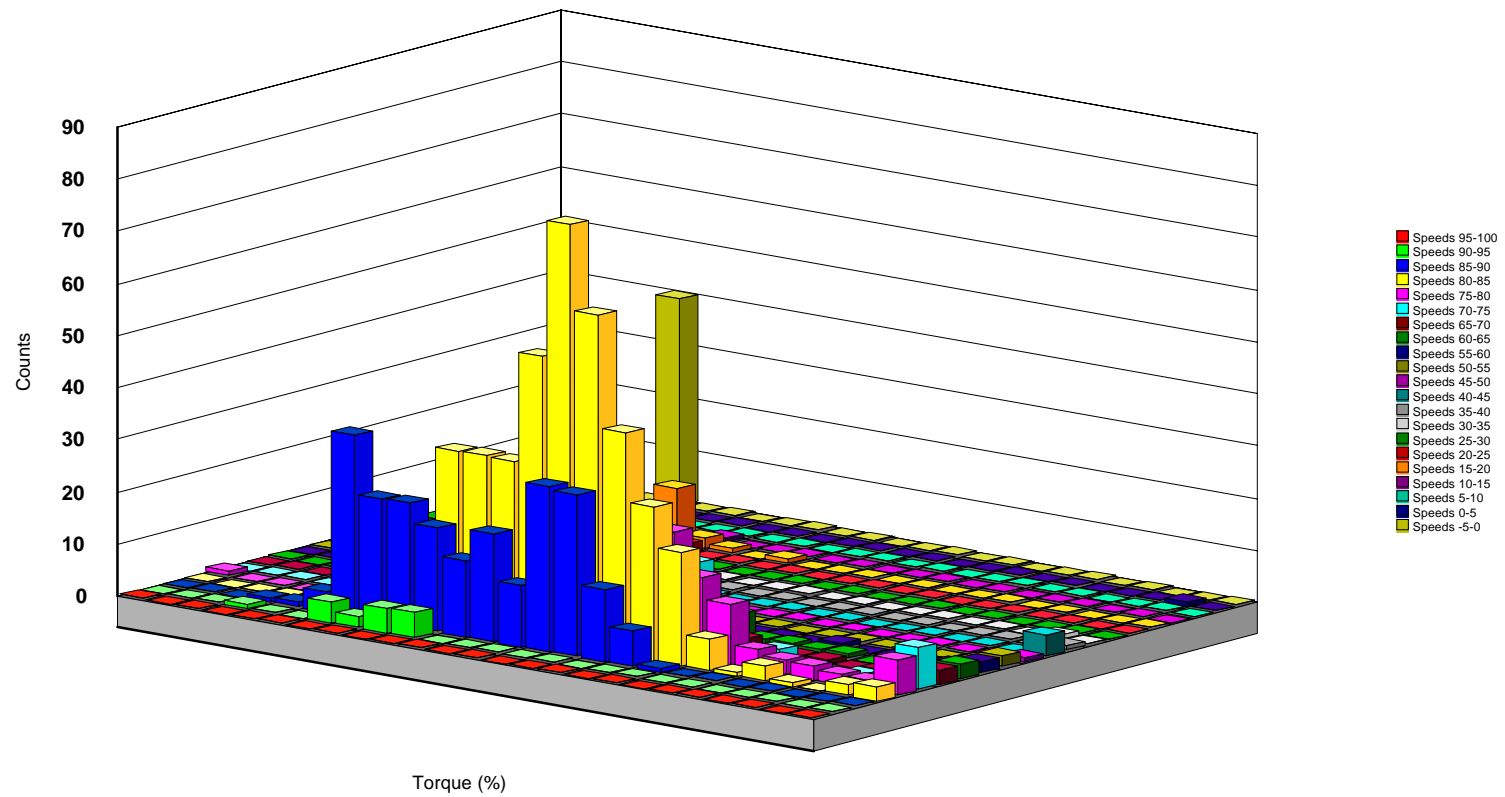
SKID STEER LOADER TYPICAL 2--Torque Steady State Means



**SKID STEER LOADER TYPICAL 2--Torque Steady State Standard Deviations**

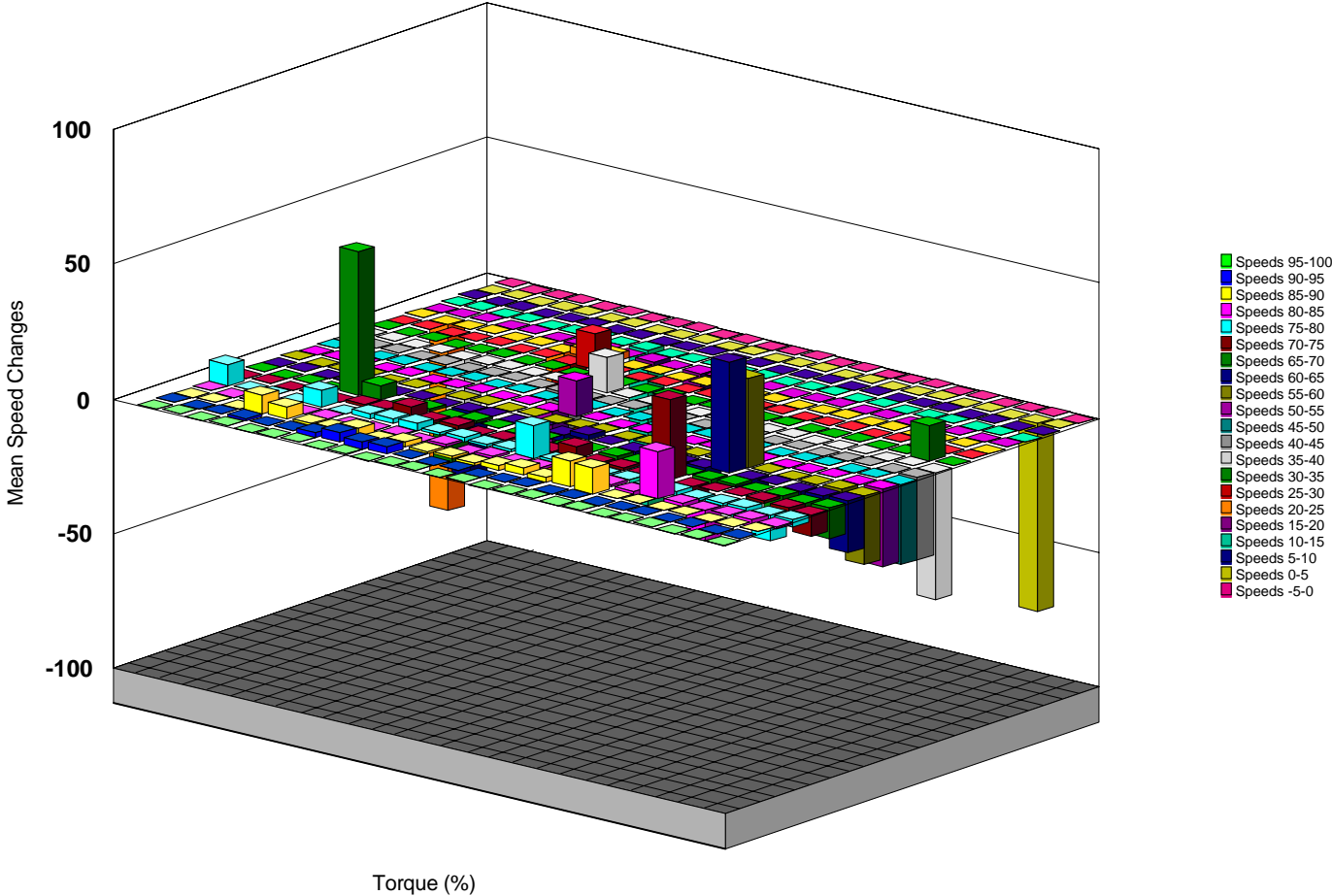


## SKID STEER LOADER HIGH SPEED TRANSIENT--Counts

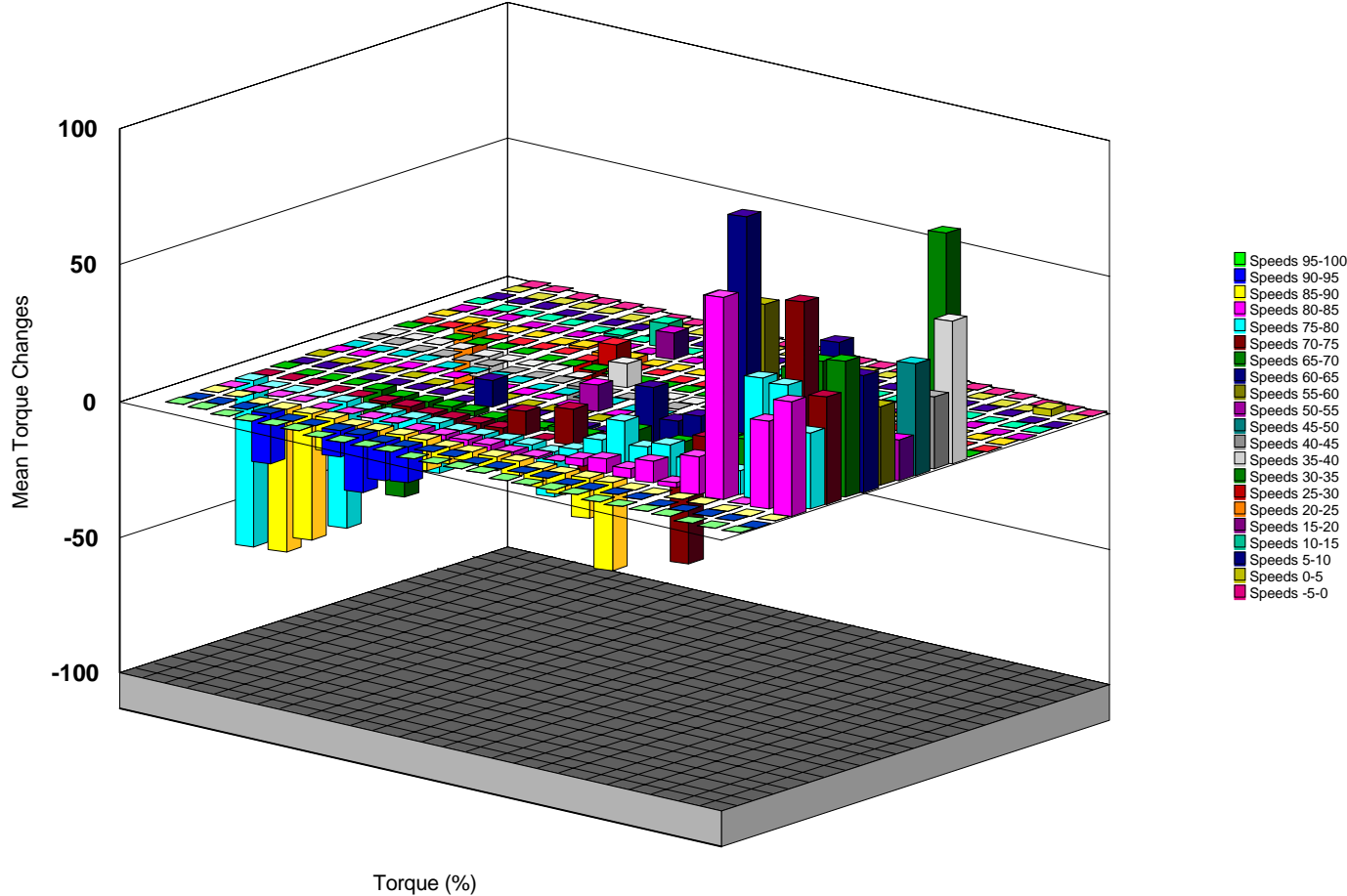




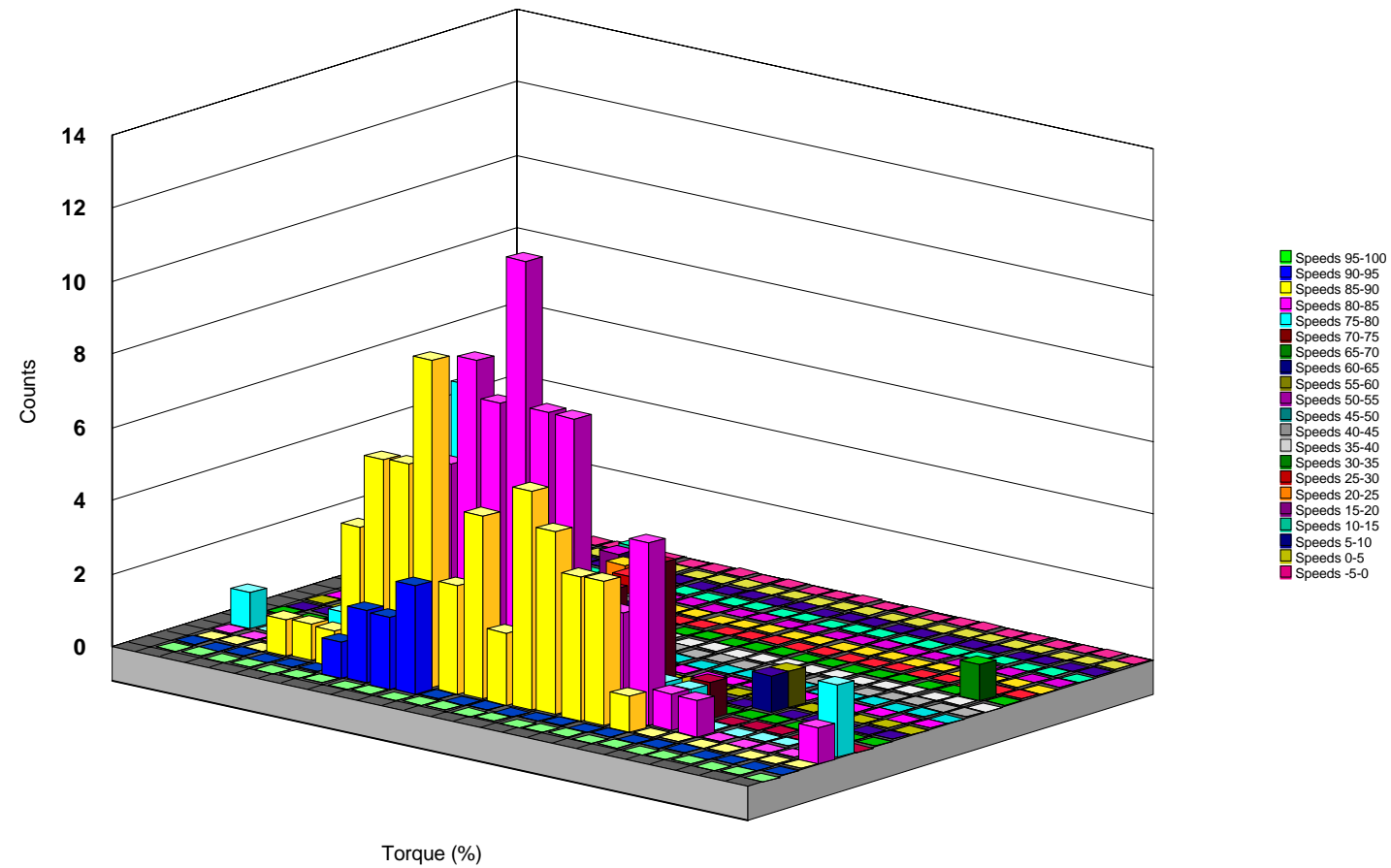
**SKID STEER LOADER HIGH SPEED TRANSIENT--Mean Speed Changes**



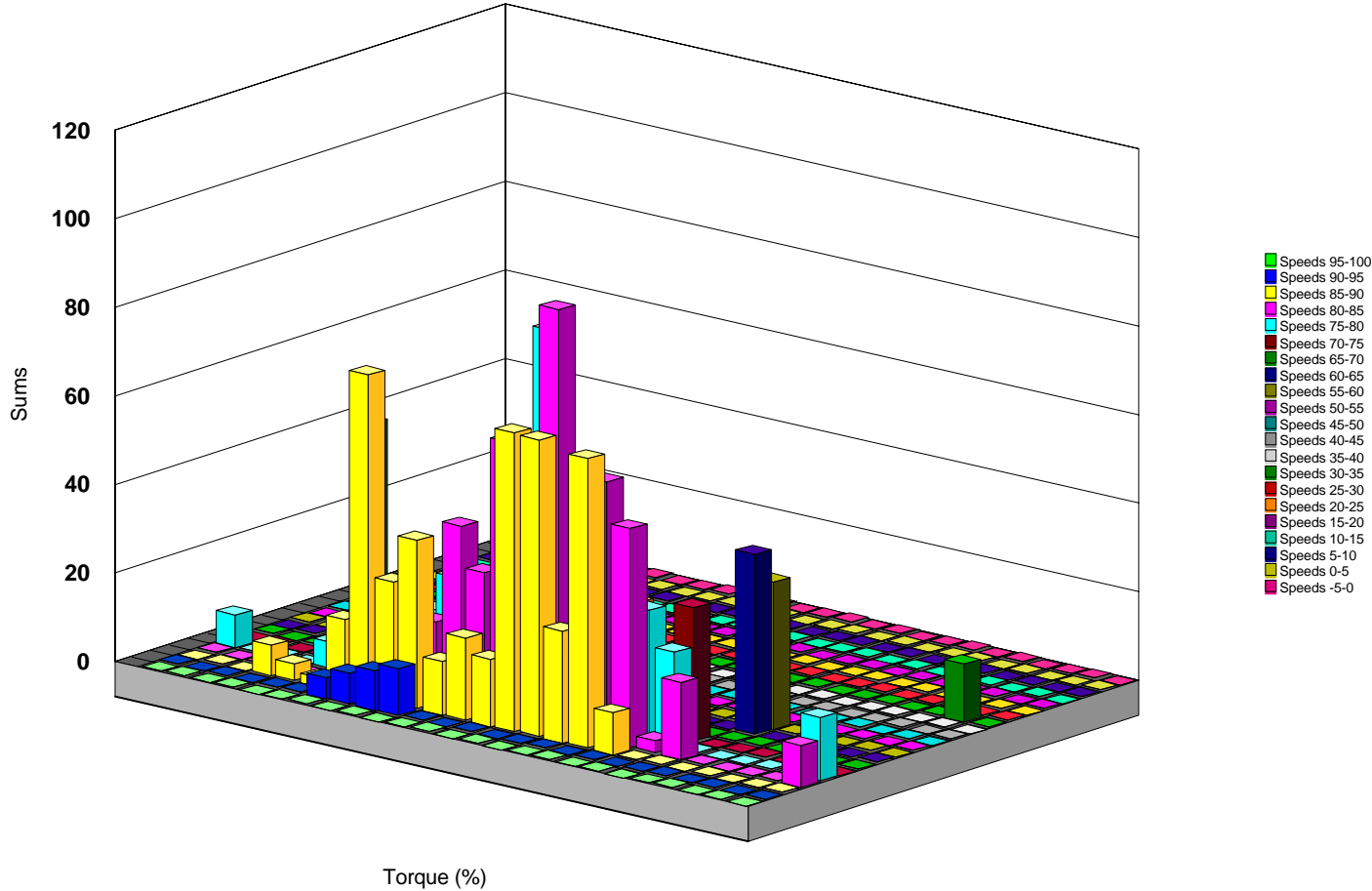
# SKID STEER LOADER HIGH SPEED TRANSIENT--Mean Torque Changes



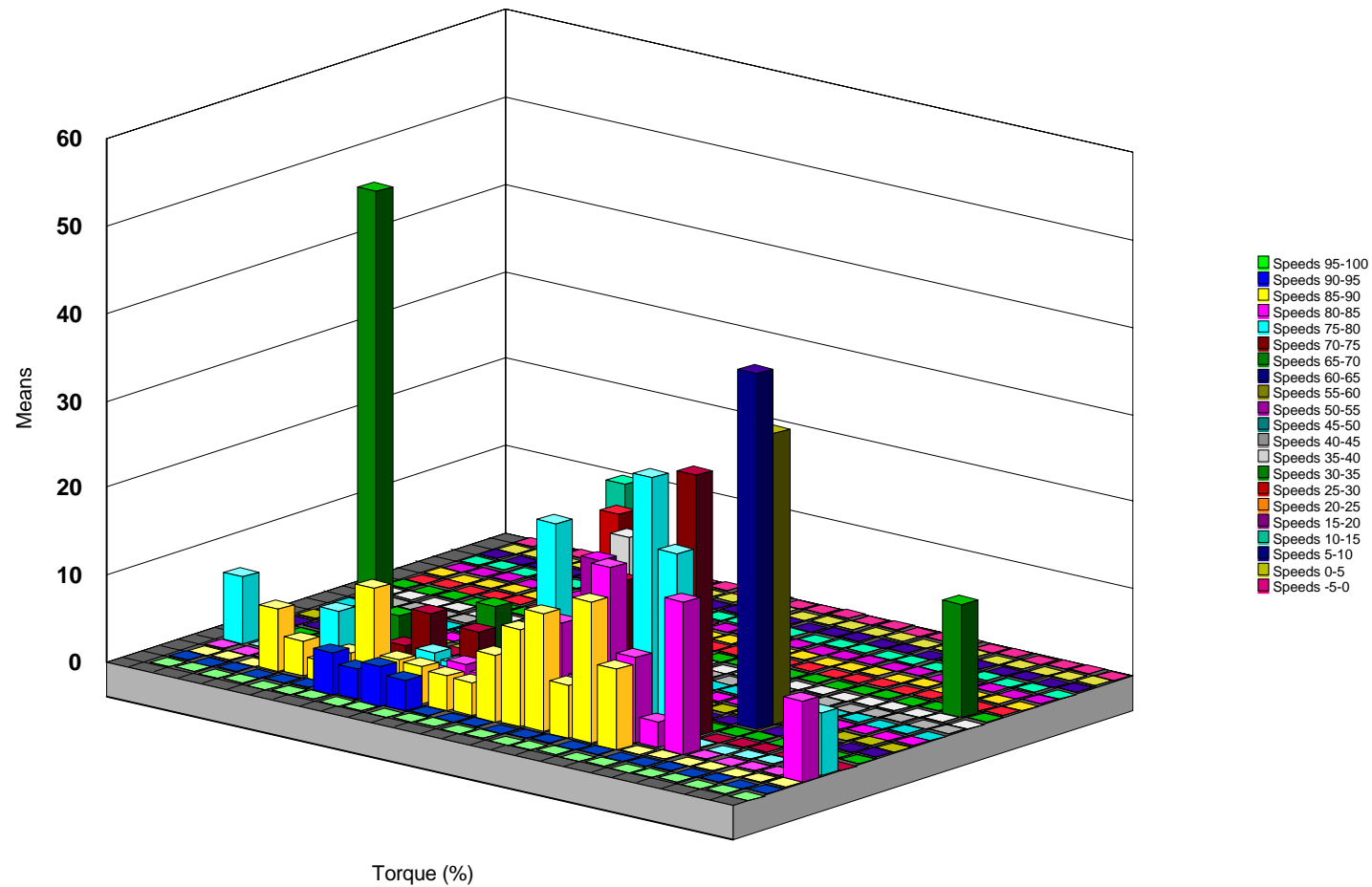
## SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Acceleration Counts



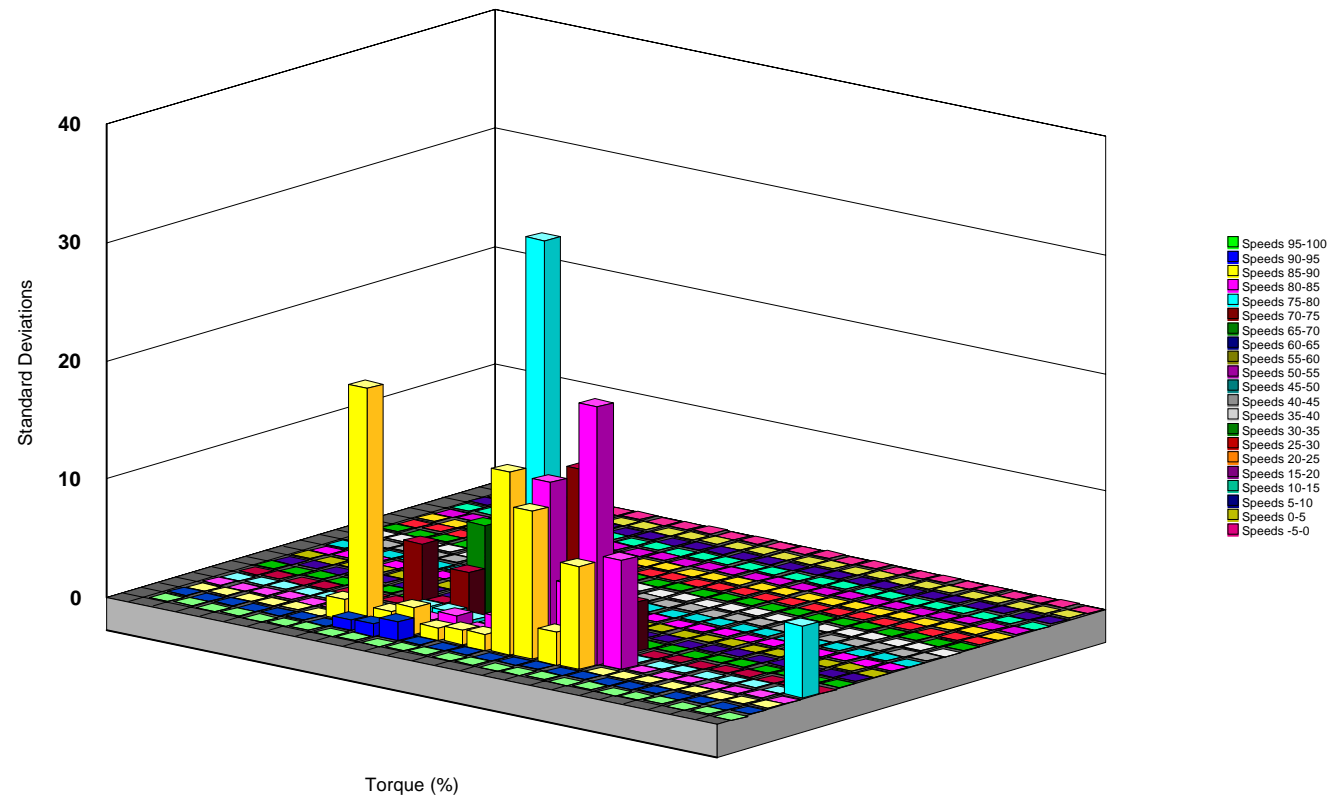
SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Acceleration Sums



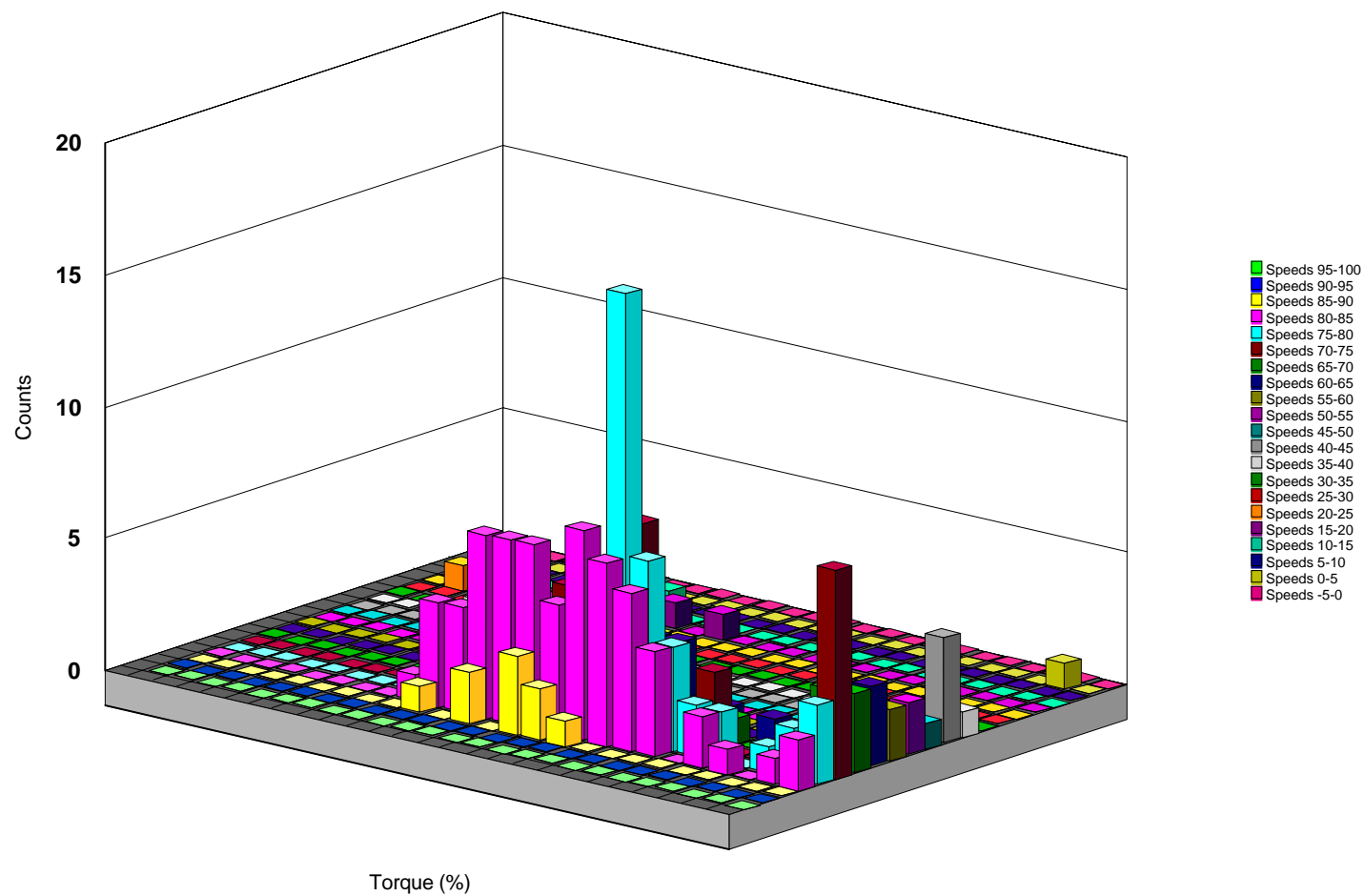
## SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Acceleration Means



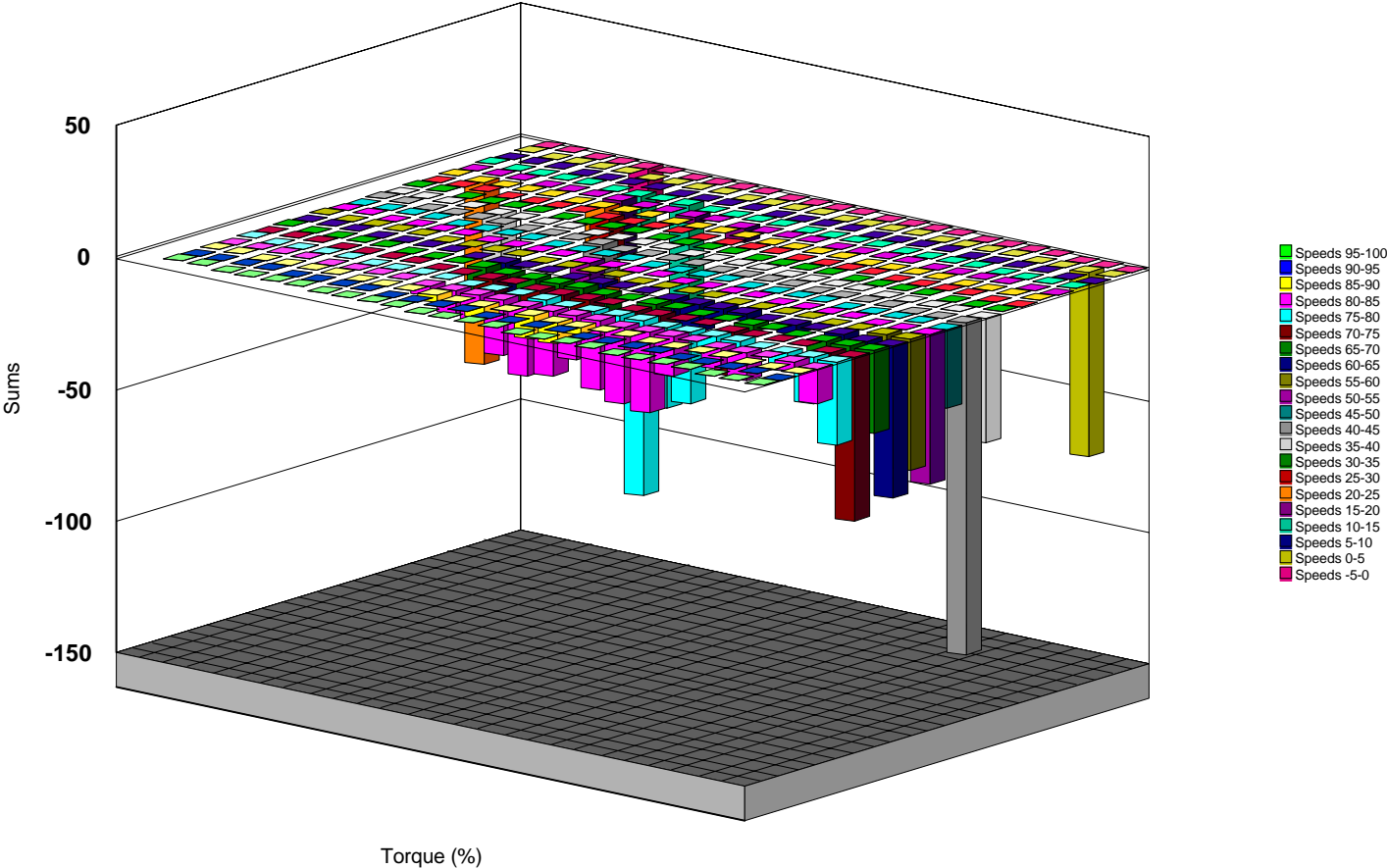
# SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Acceleration Standard Deviations



## SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Deceleration Count

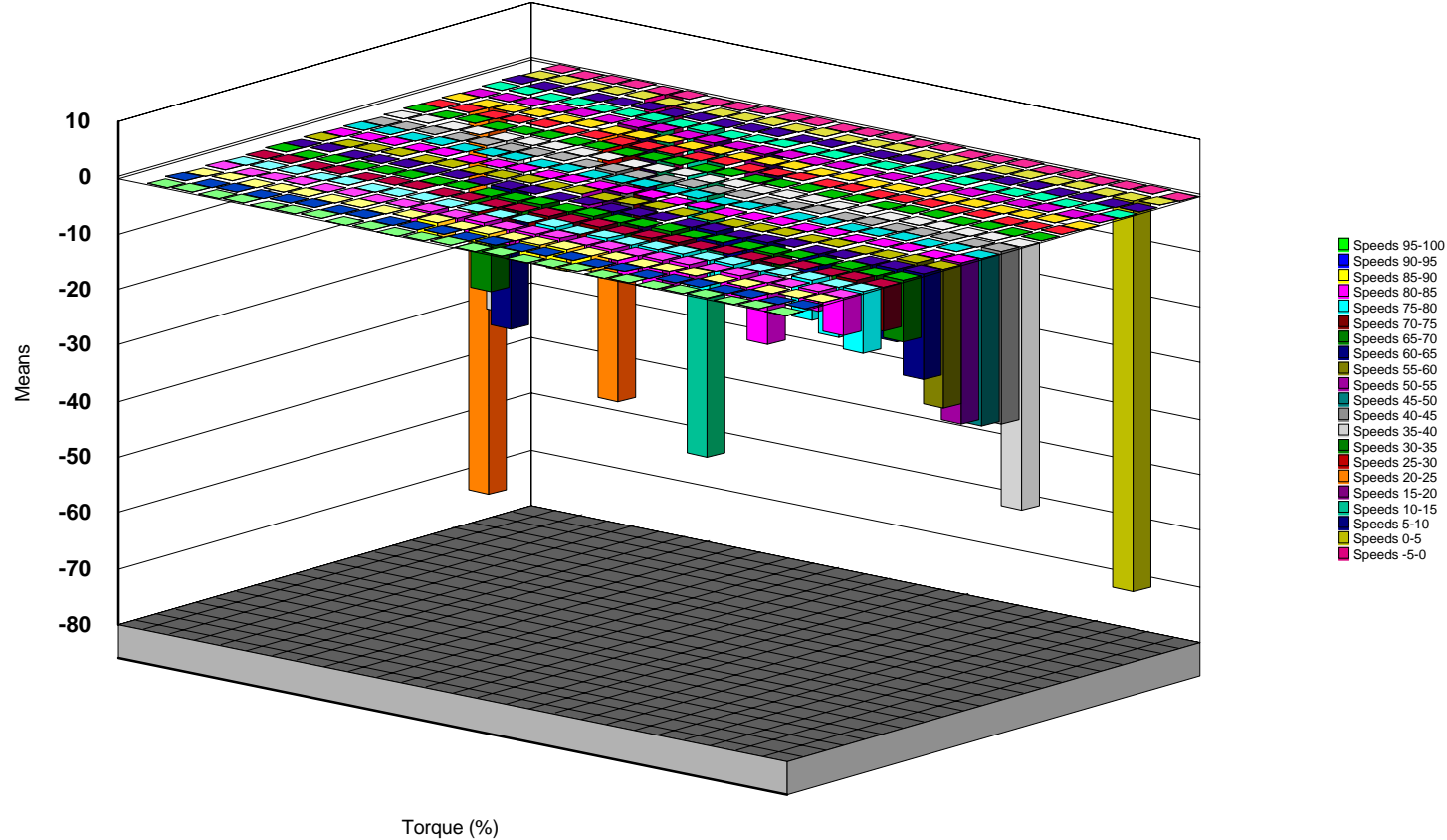


# SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Deceleration Sums

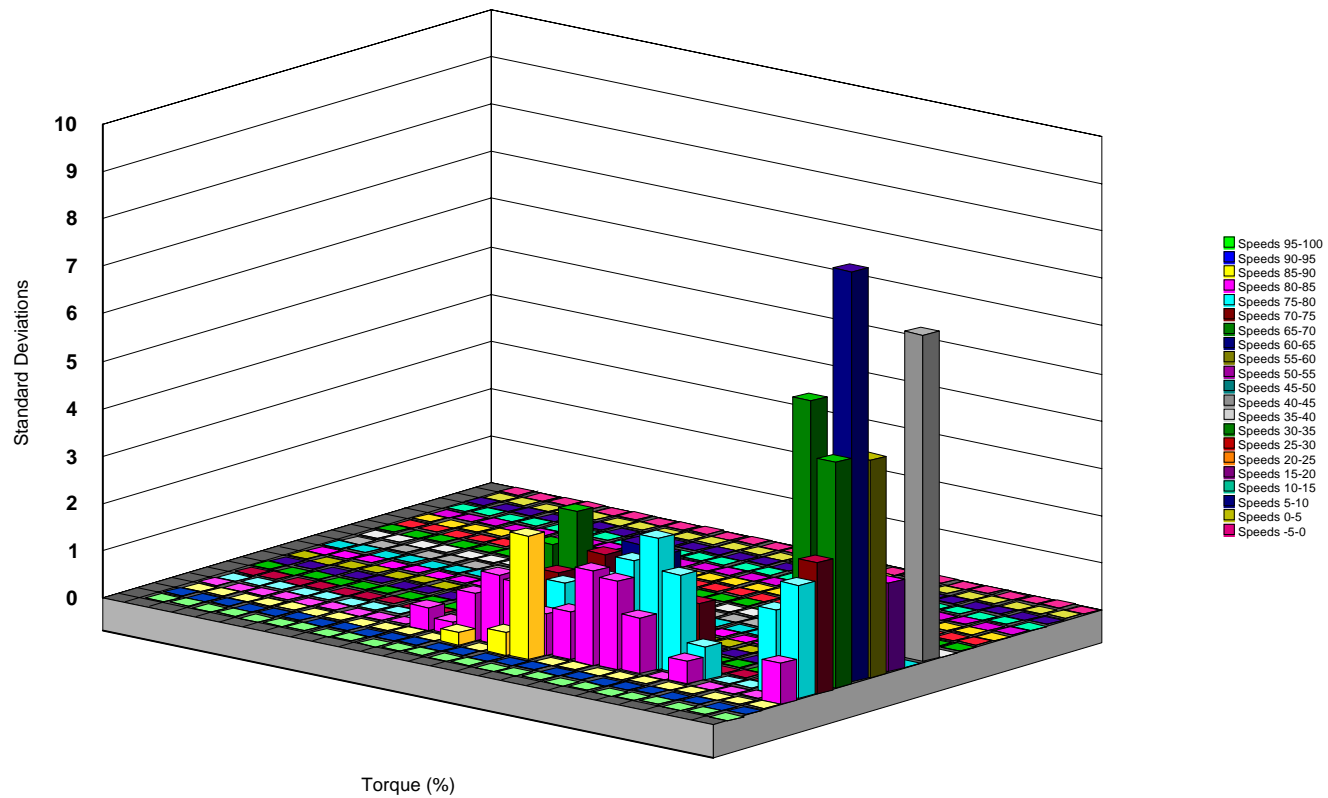




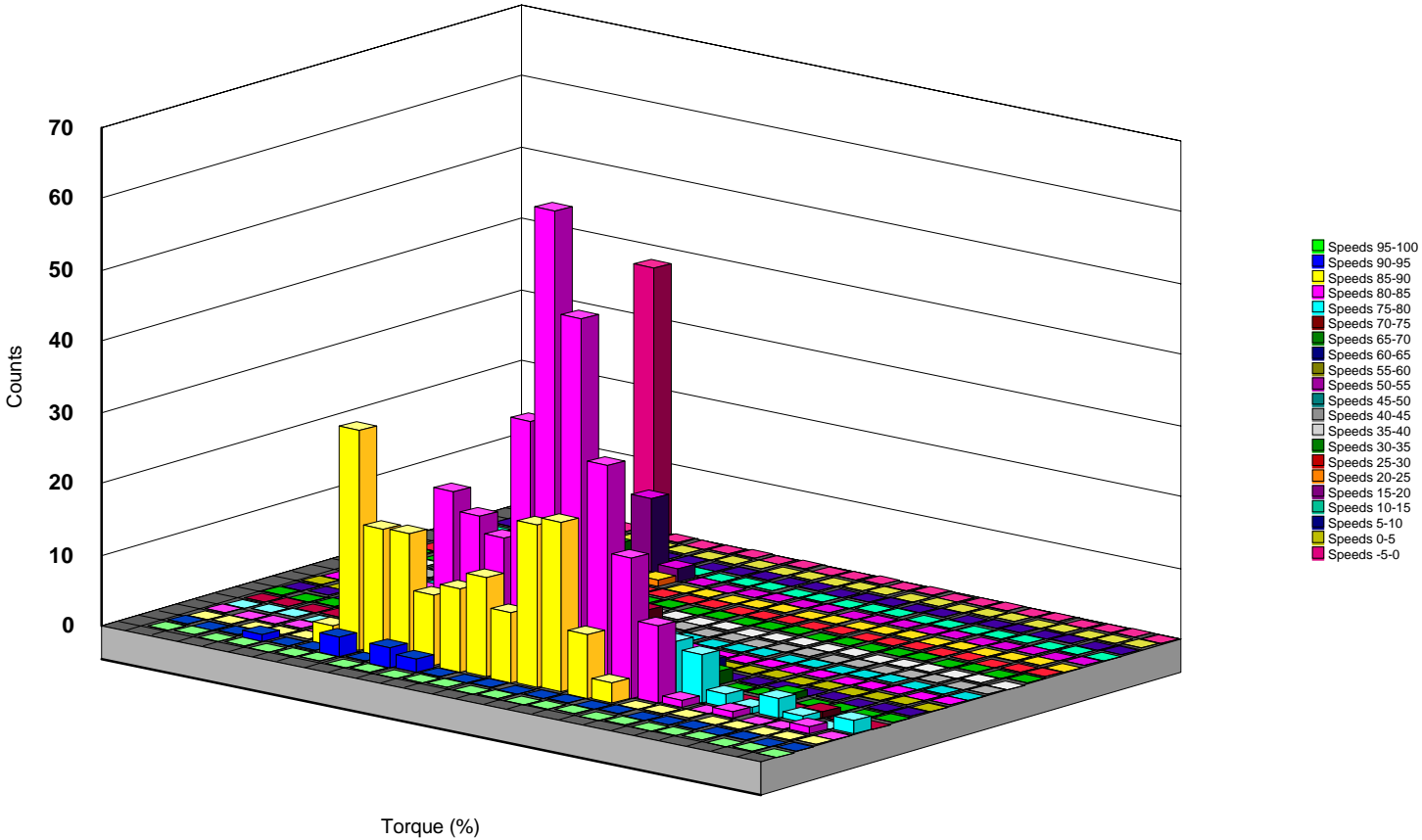
SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Deceleration Means



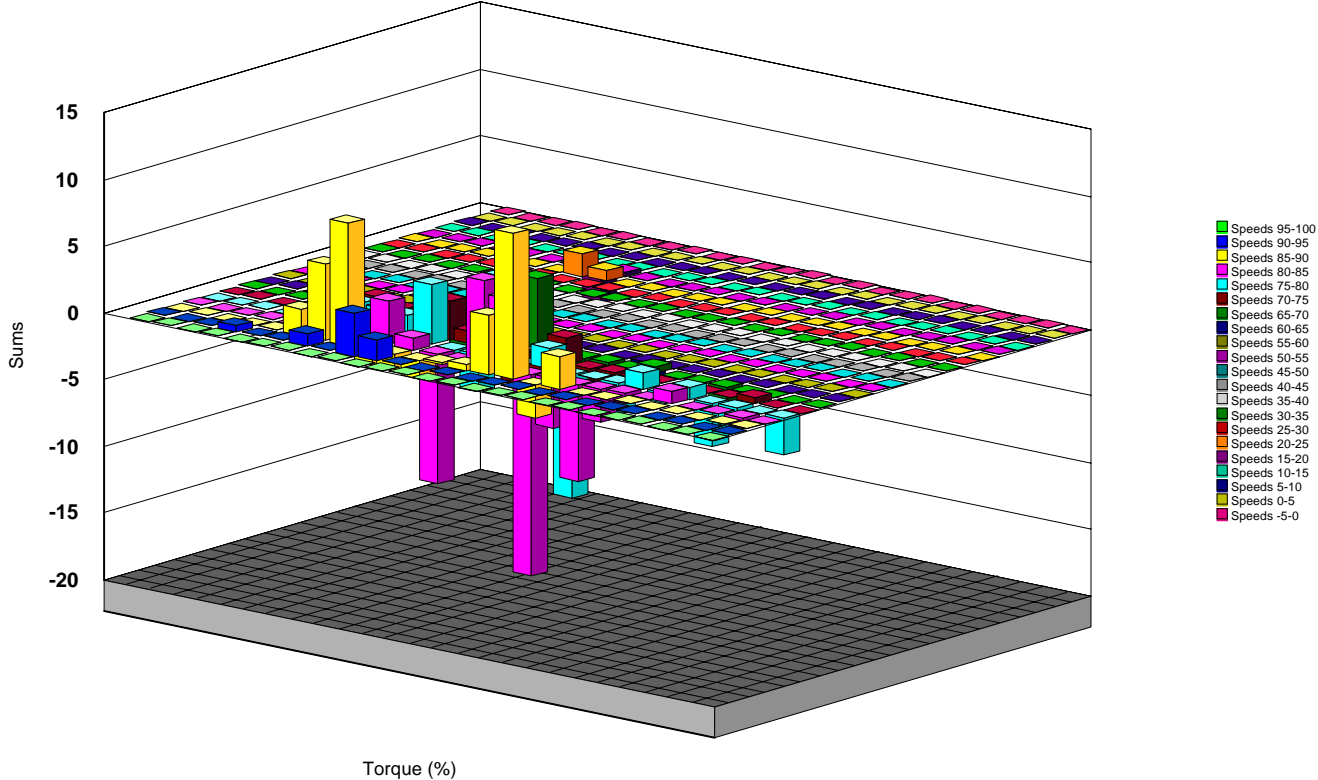
### SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Deceleration Standard Deviations



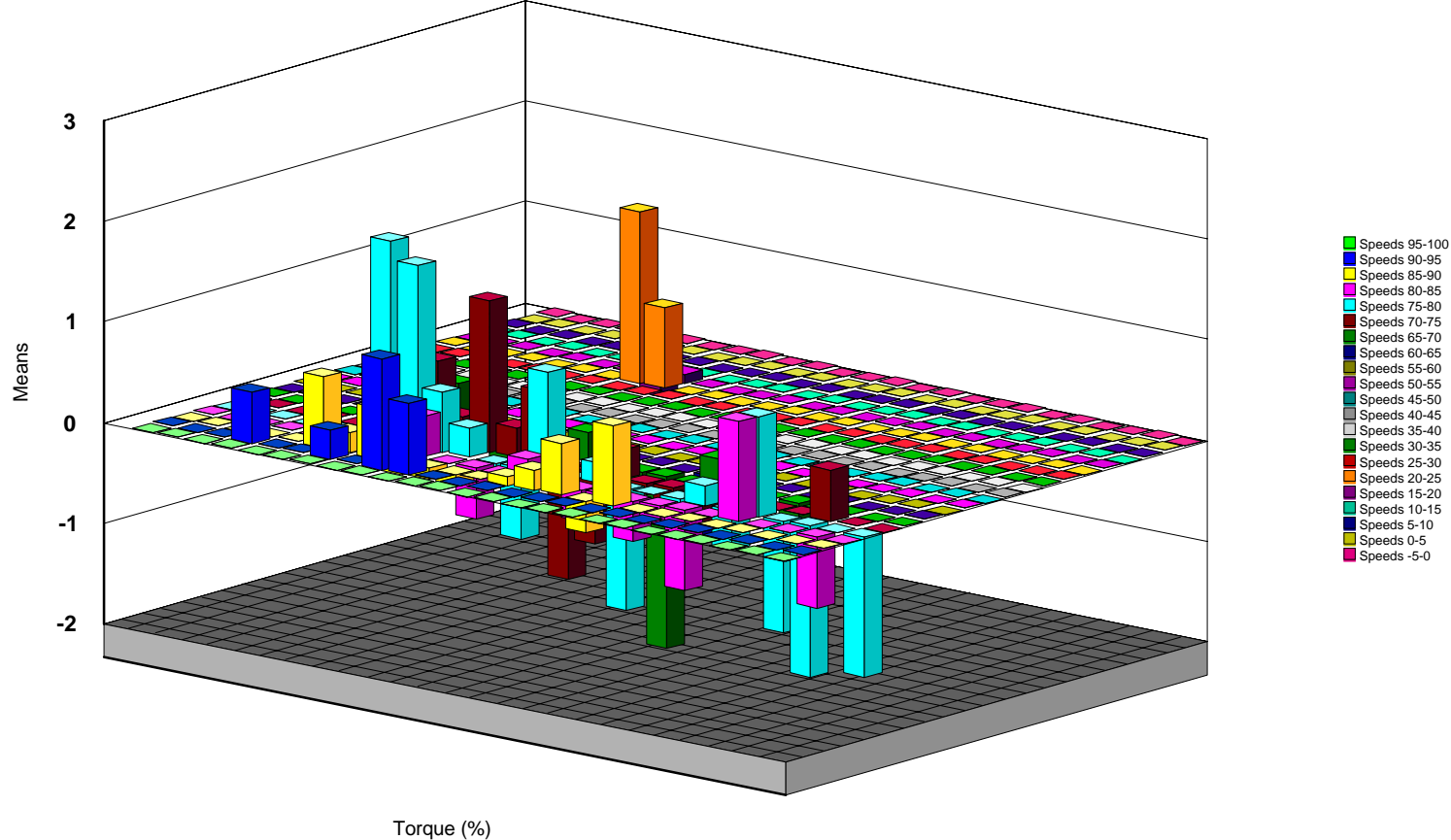
## SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Steady State Counts



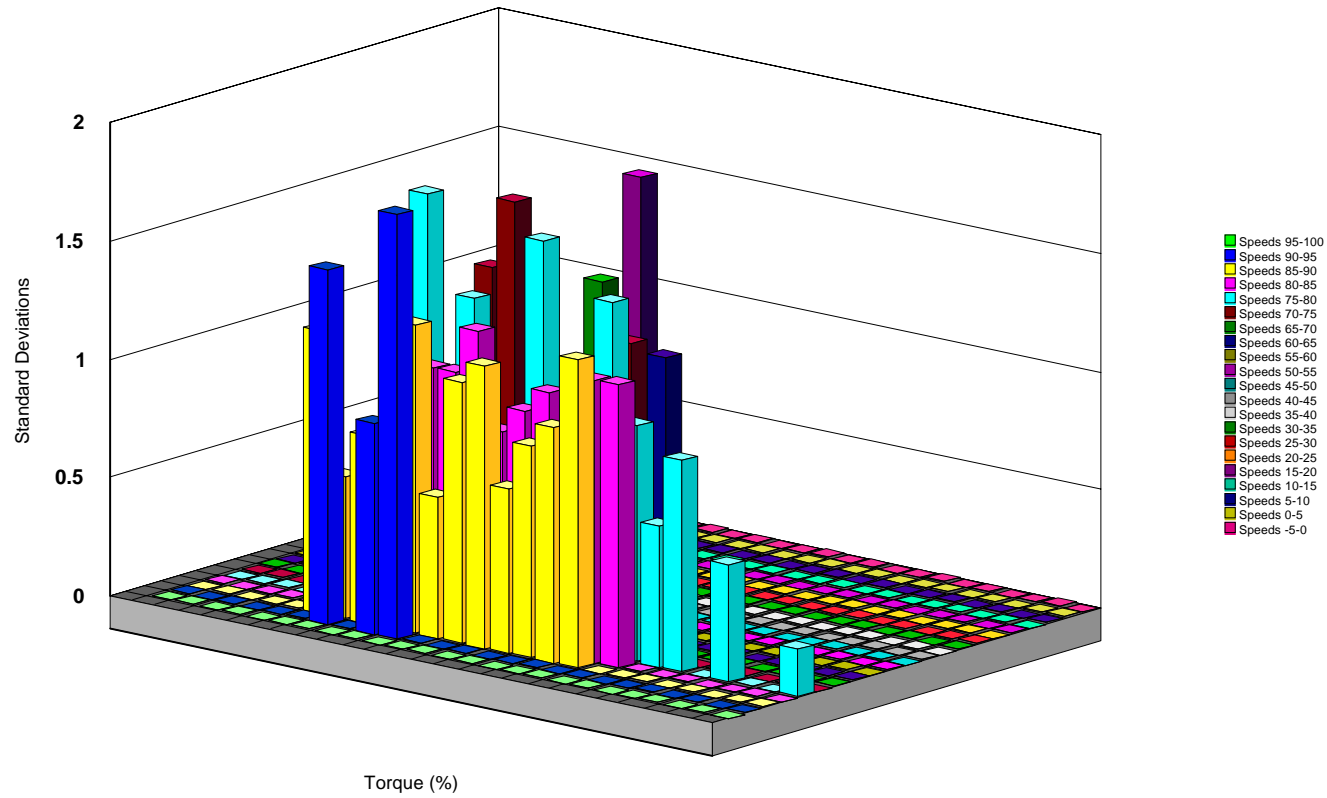
SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Steady State Sums



SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Steady State Means



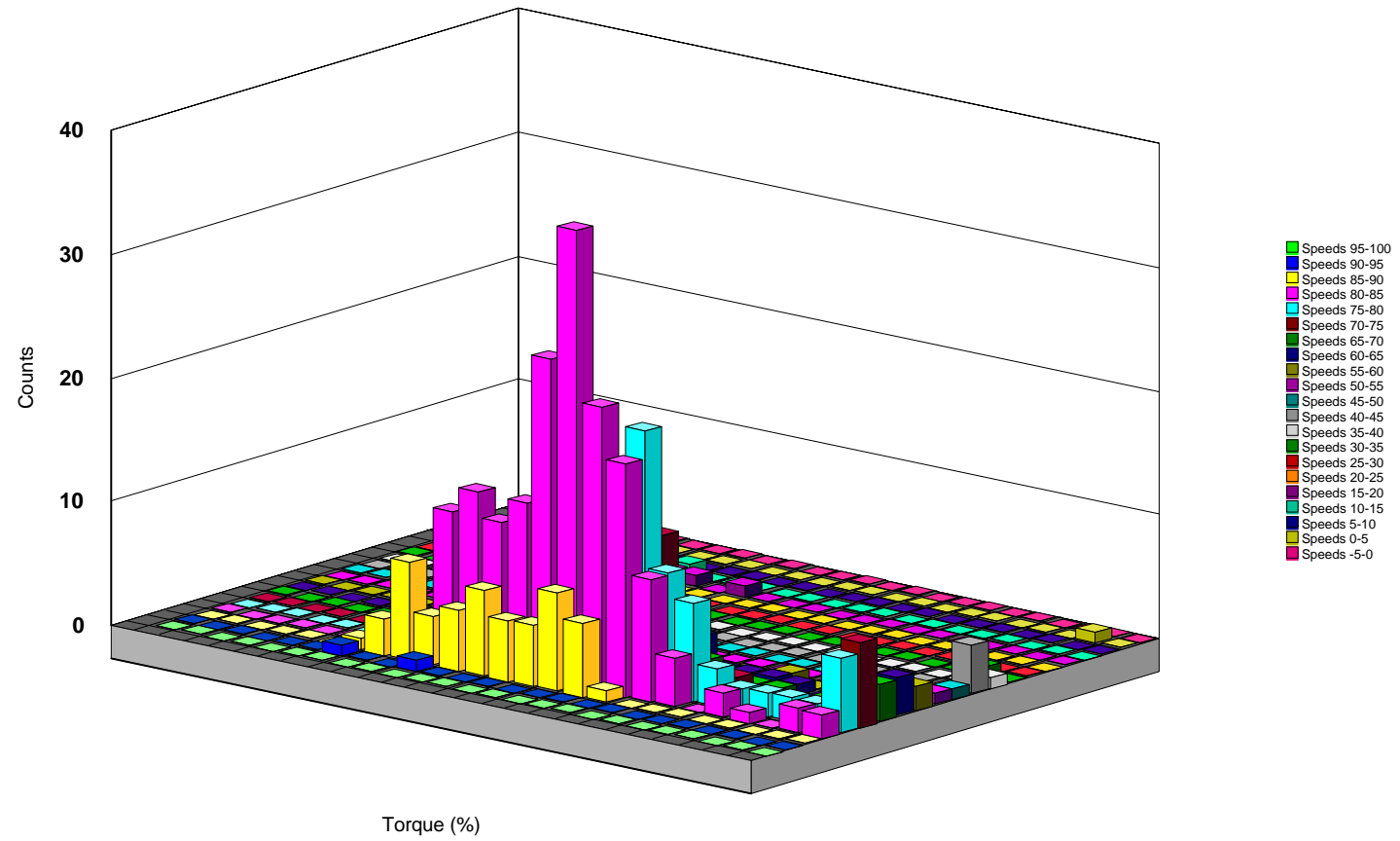
### SKID STEER LOADER HIGH SPEED TRANSIENT--Speed Steady State Standard Deviations



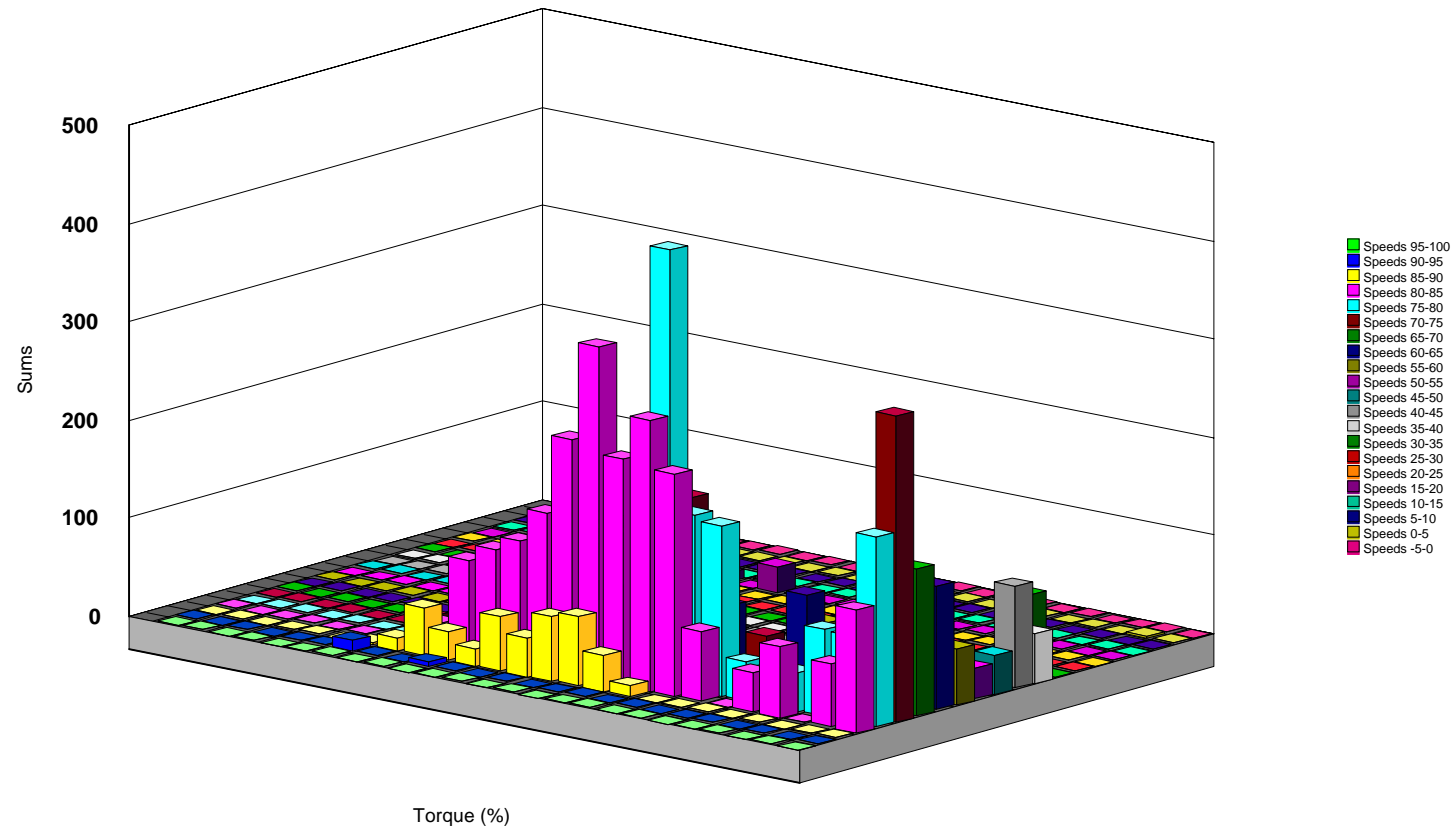
A 3D bar chart illustrating the distribution of counts across different torque and speed ranges. The x-axis represents Torque (%), the y-axis represents Counts, and the z-axis represents speed ranges. The chart shows a significant peak in counts for the 80-85 speed range, reaching approximately 32 counts. Other notable peaks occur in the 75-80 and 65-70 speed ranges. The distribution is generally skewed towards higher torque values.

Legend (Speeds):

- Speeds 95-100
- Speeds 90-95
- Speeds 85-90
- Speeds 80-85
- Speeds 75-80
- Speeds 70-75
- Speeds 65-70
- Speeds 60-65
- Speeds 55-60
- Speeds 50-55
- Speeds 45-50
- Speeds 40-45
- Speeds 35-40
- Speeds 30-35
- Speeds 25-30
- Speeds 20-25
- Speeds 15-20
- Speeds 10-15
- Speeds 5-10
- Speeds 0-5
- Speeds -5-0

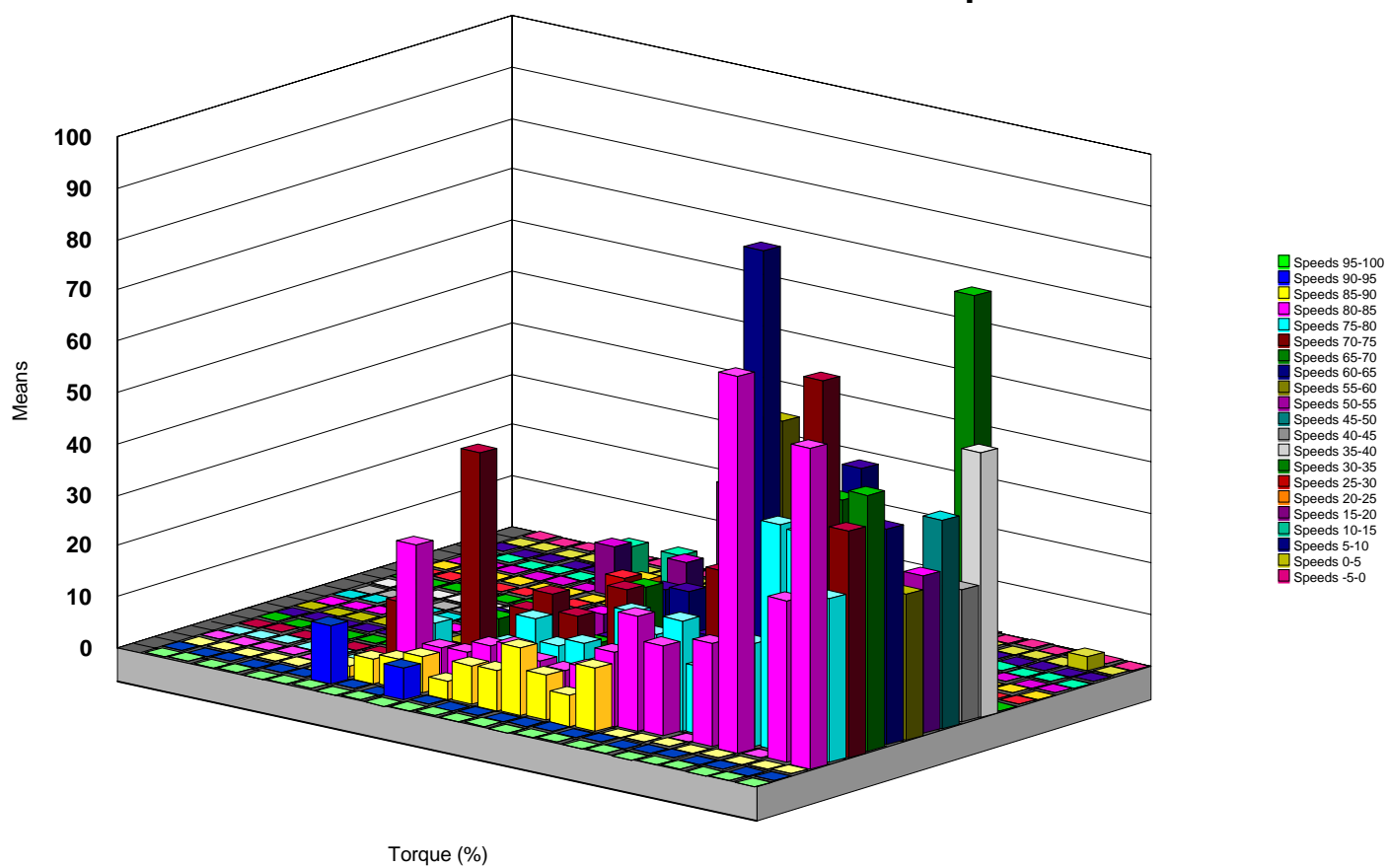


## SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Acceleration Sums

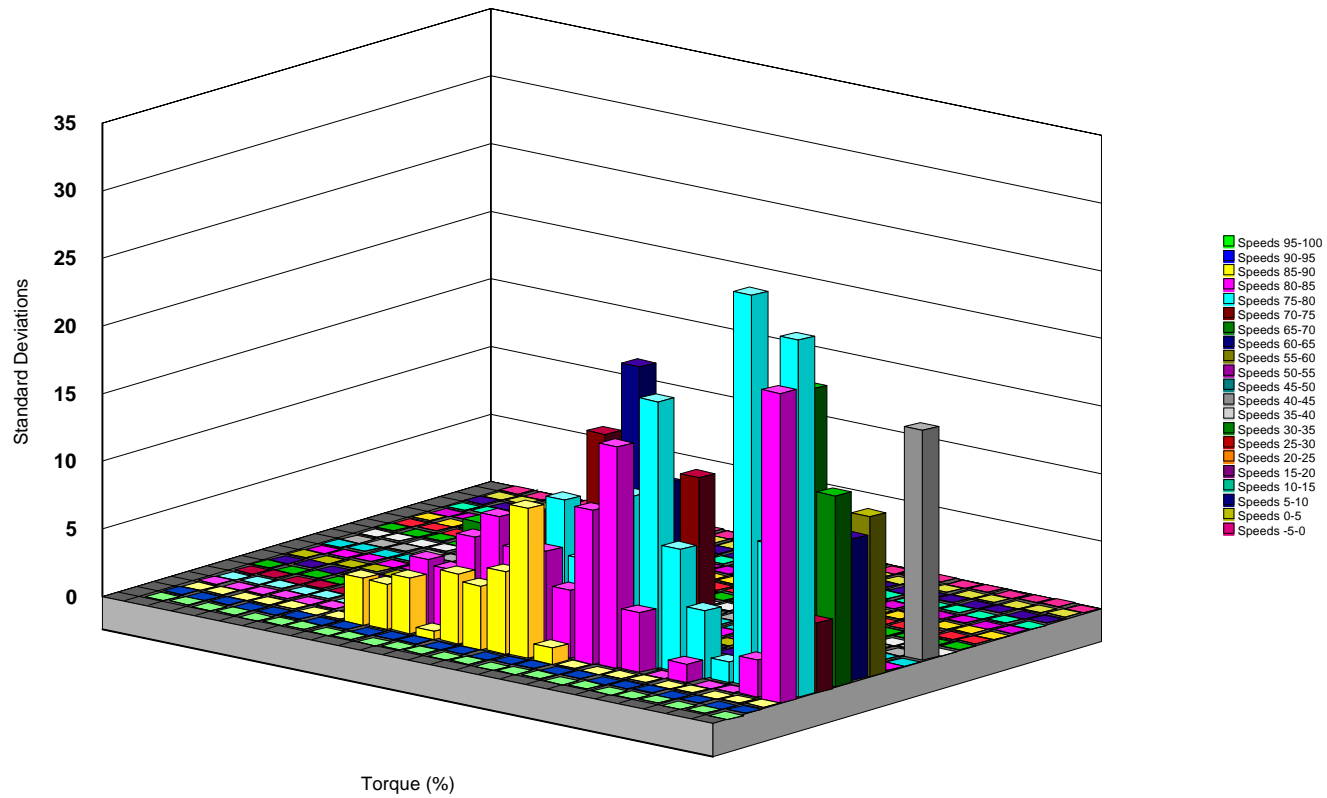




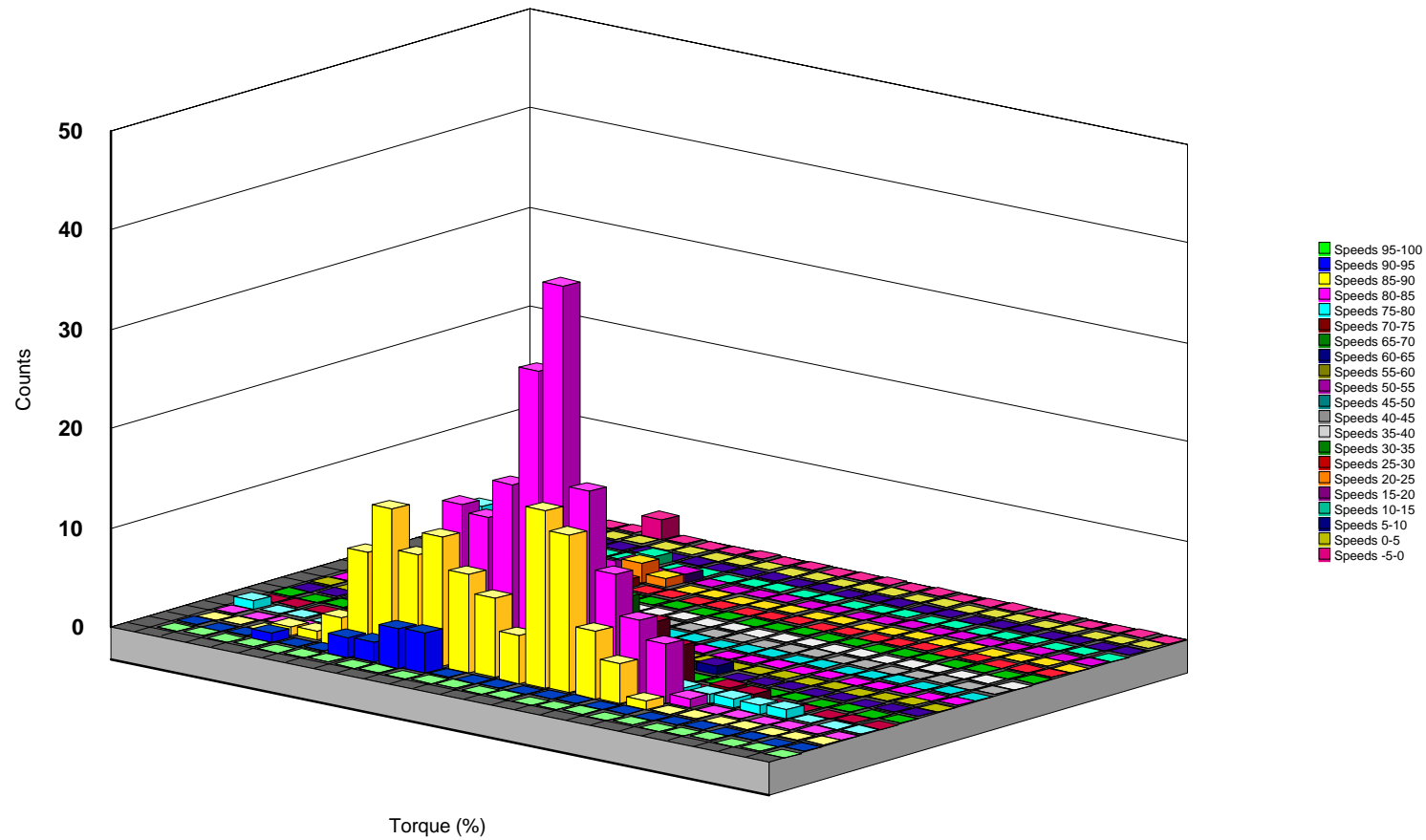
## SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Acceleration Means



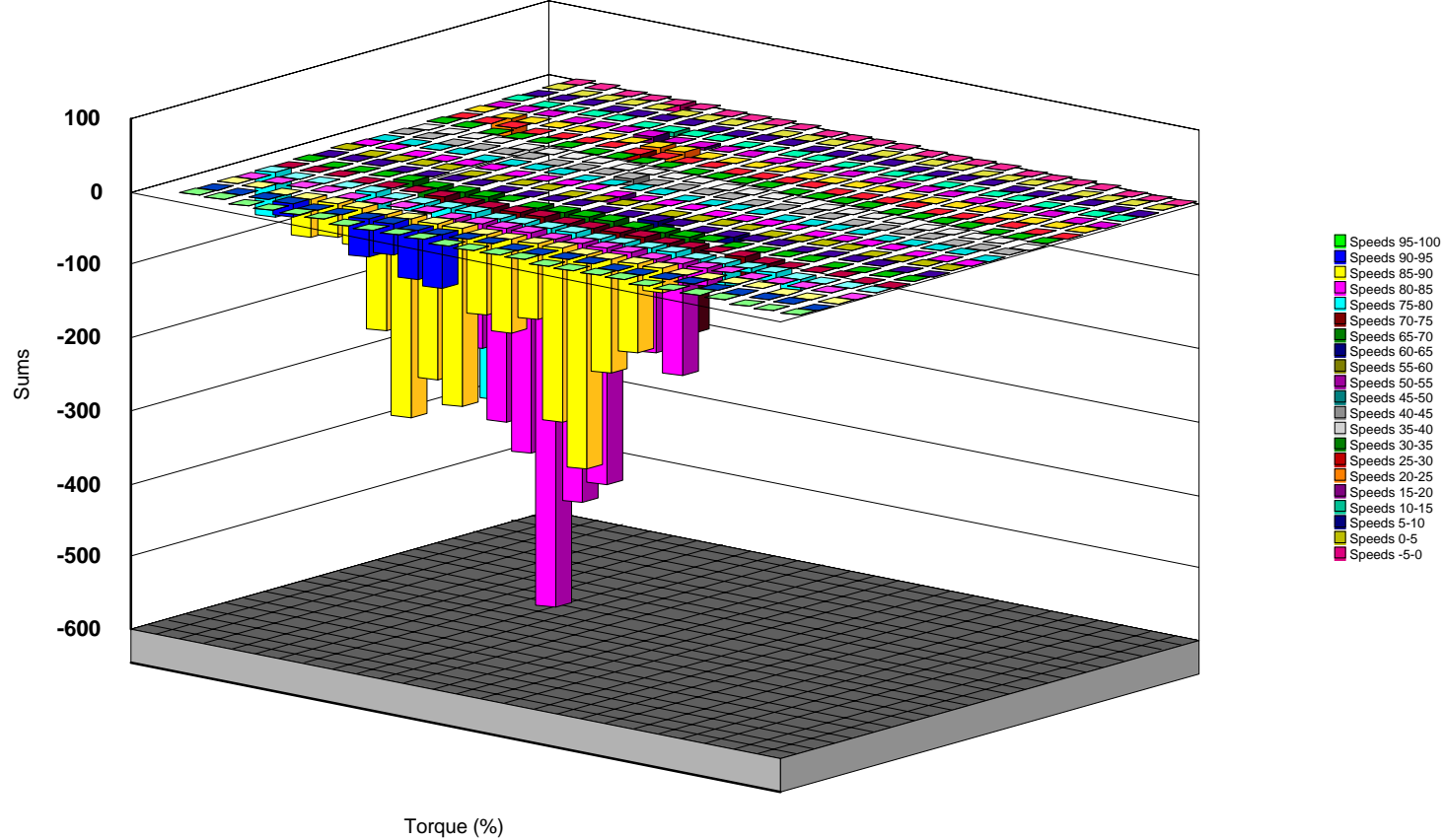
### SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Acceleration Standard Deviations



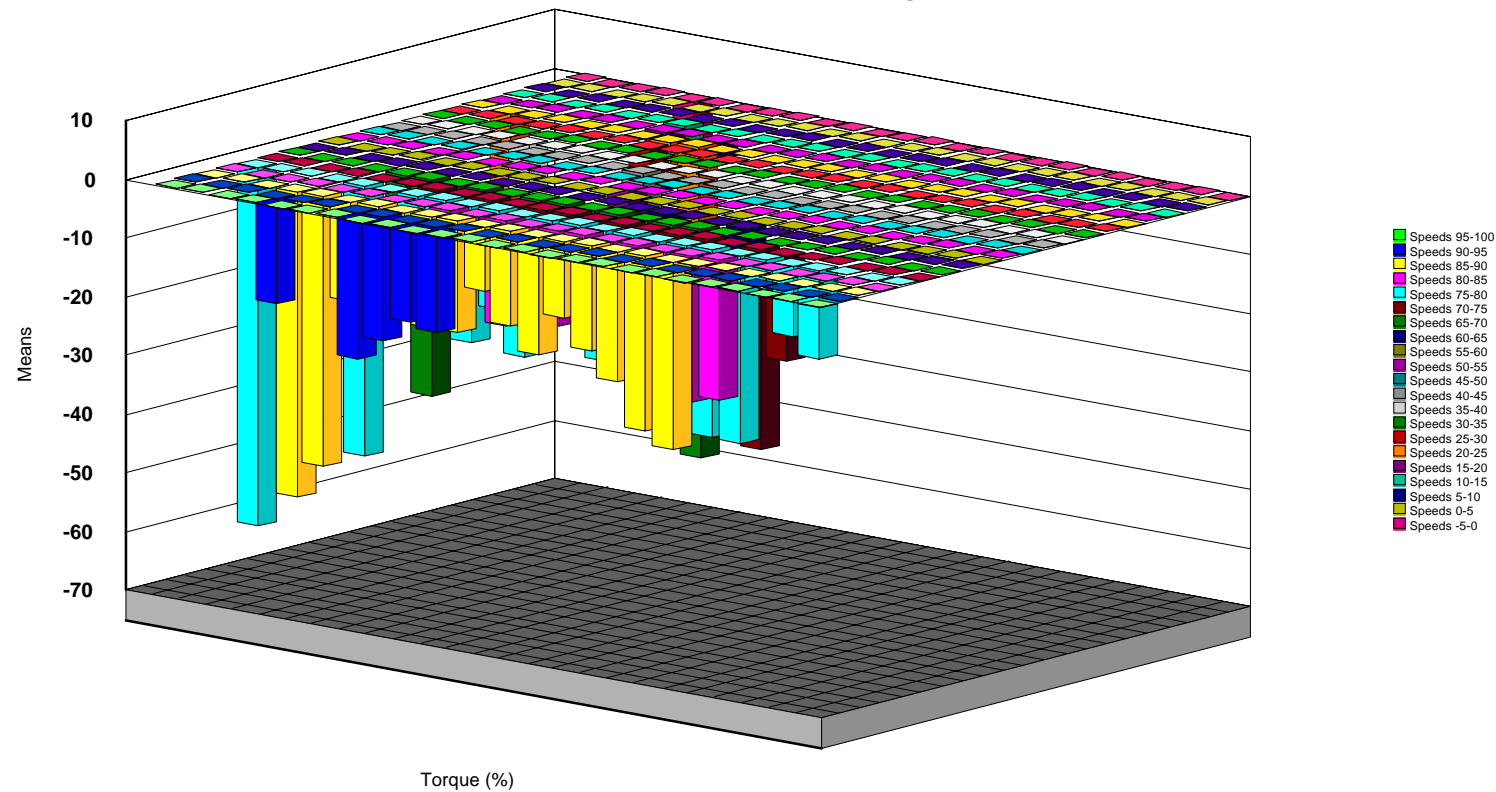
## SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Deceleration Counts



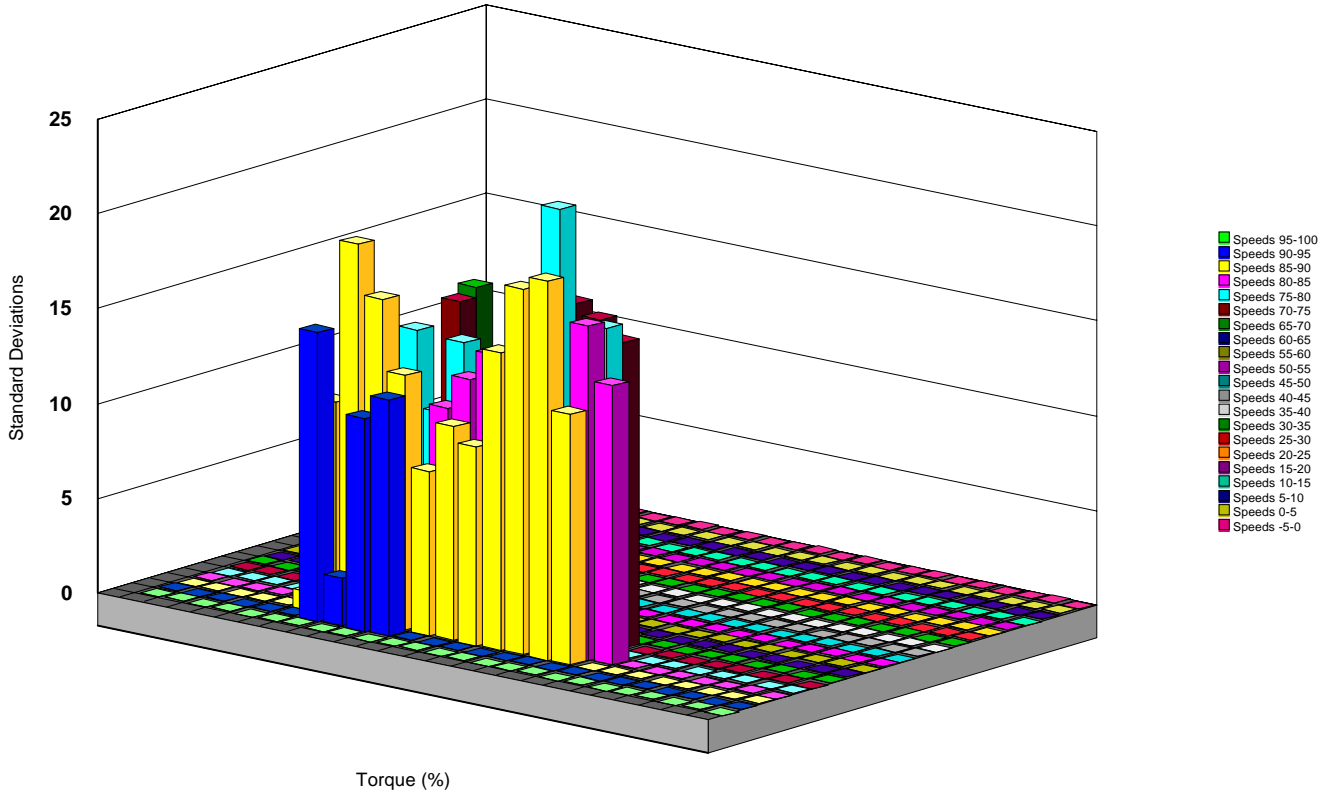
SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Deceleration Sums



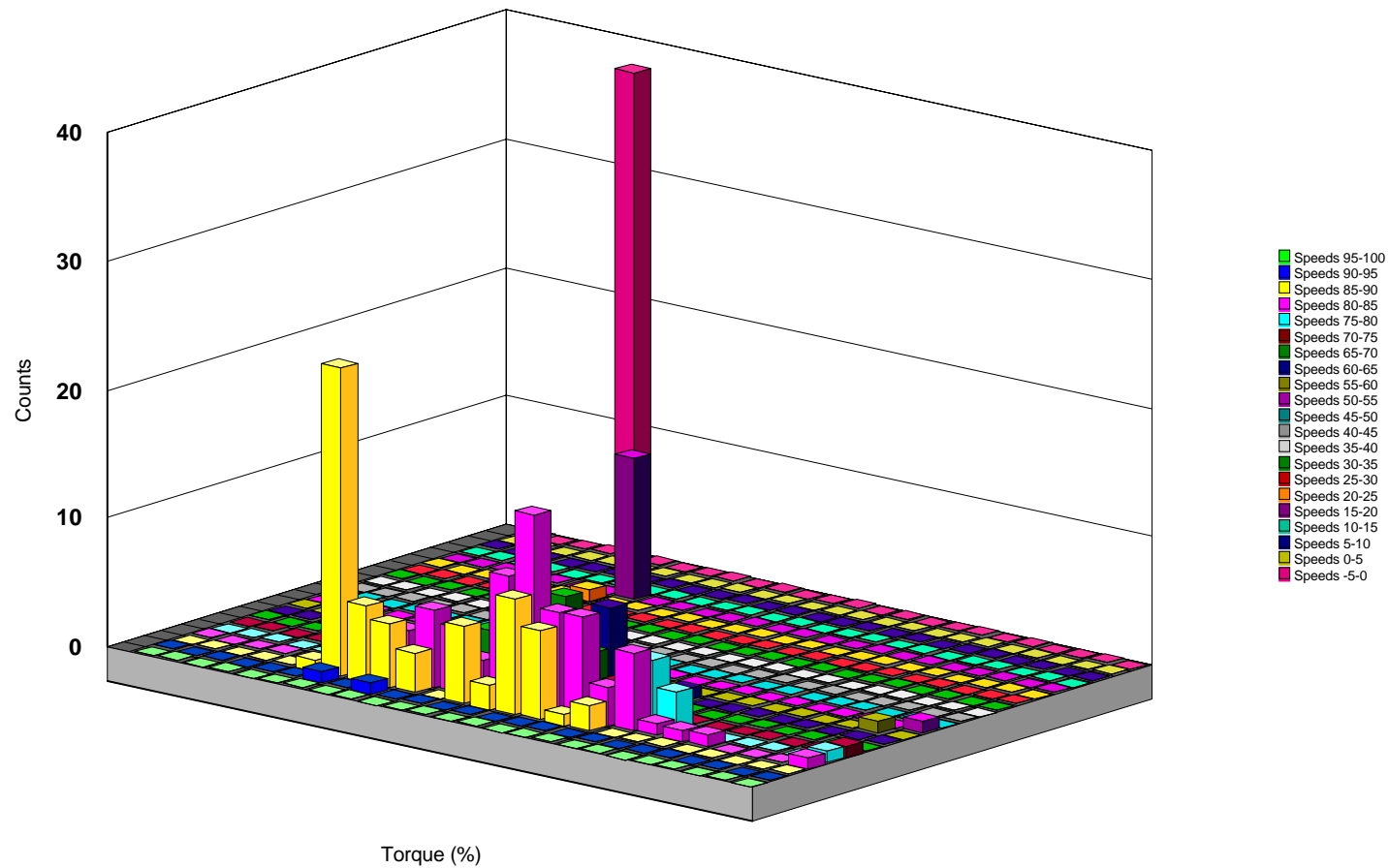
SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Deceleration Means



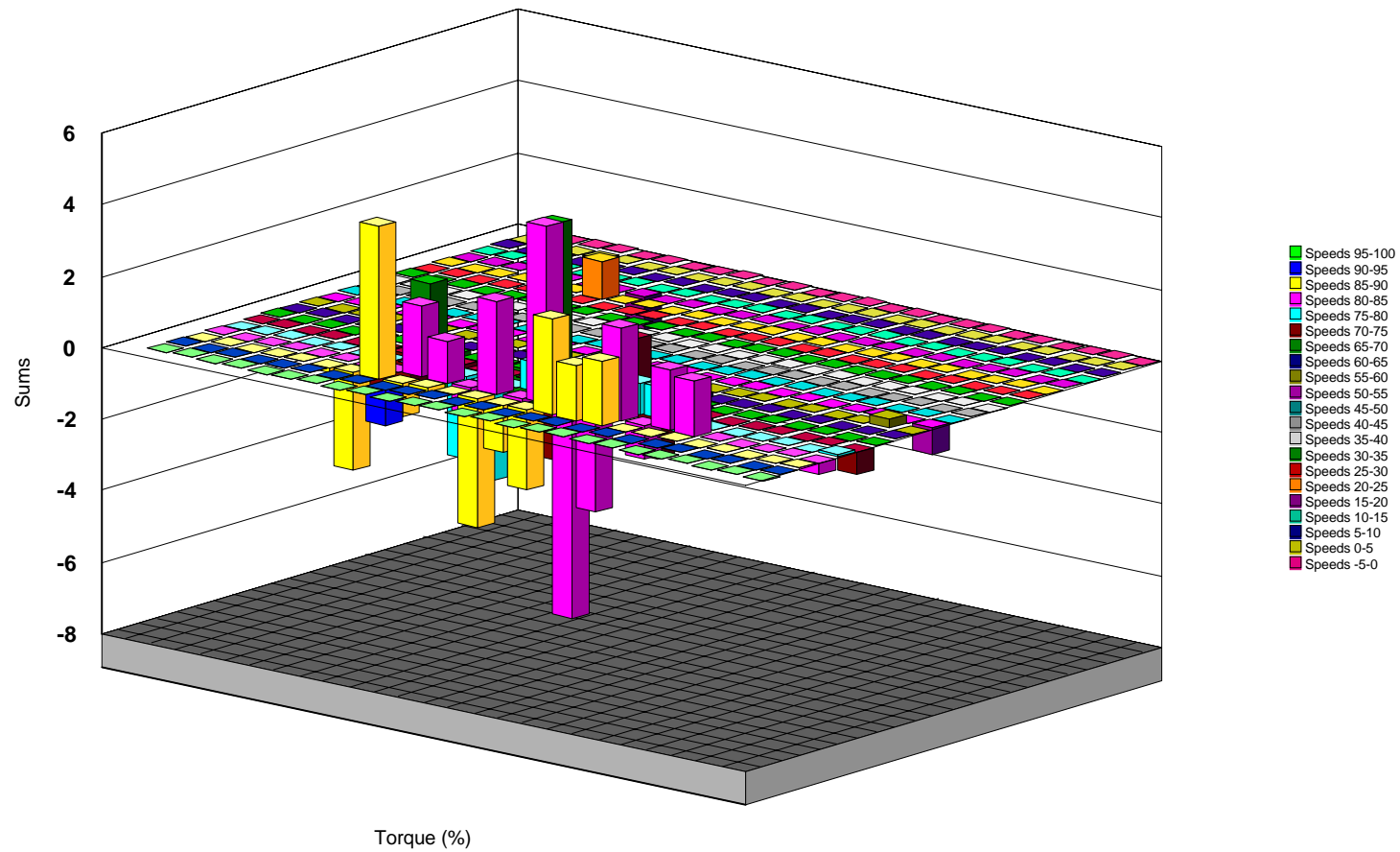
SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Deceleration Standard Deviations



## SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Steady State Counts

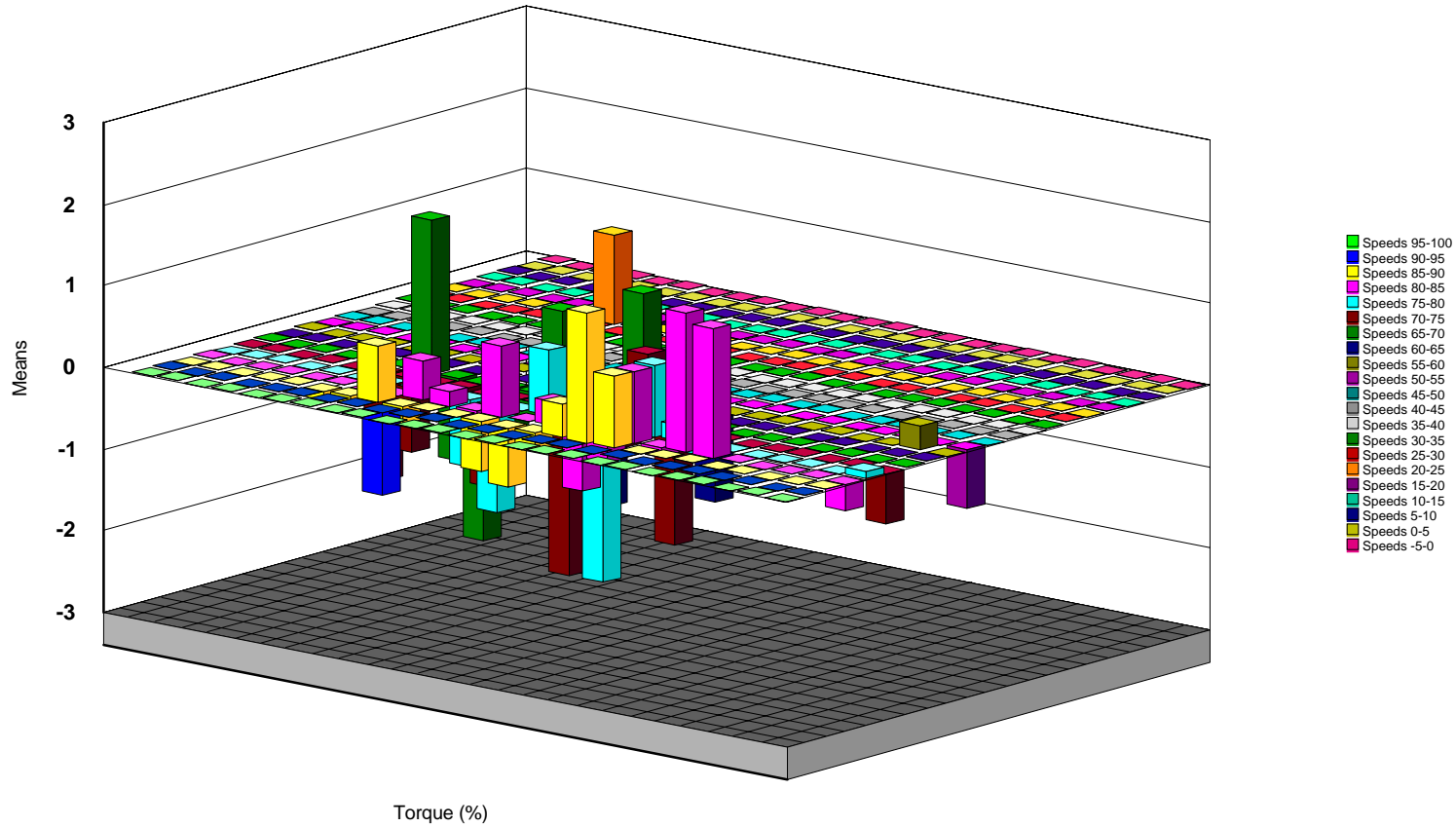


## SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Steady State Sums

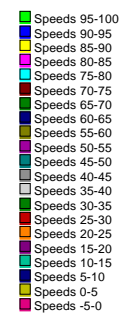




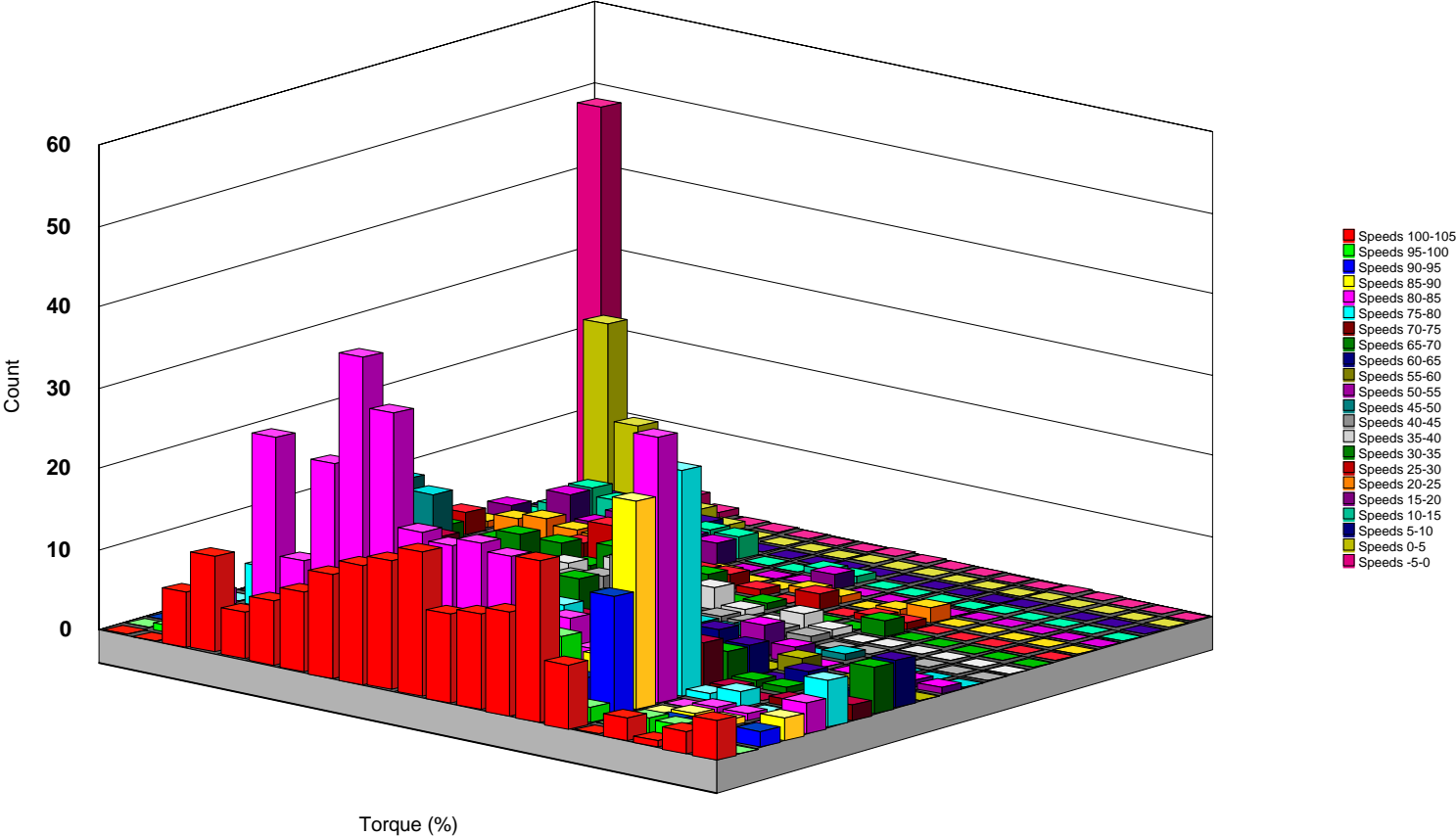
## SKID STEER LOADER HIGH SPEED TRANSIENT--Torque Steady State Means



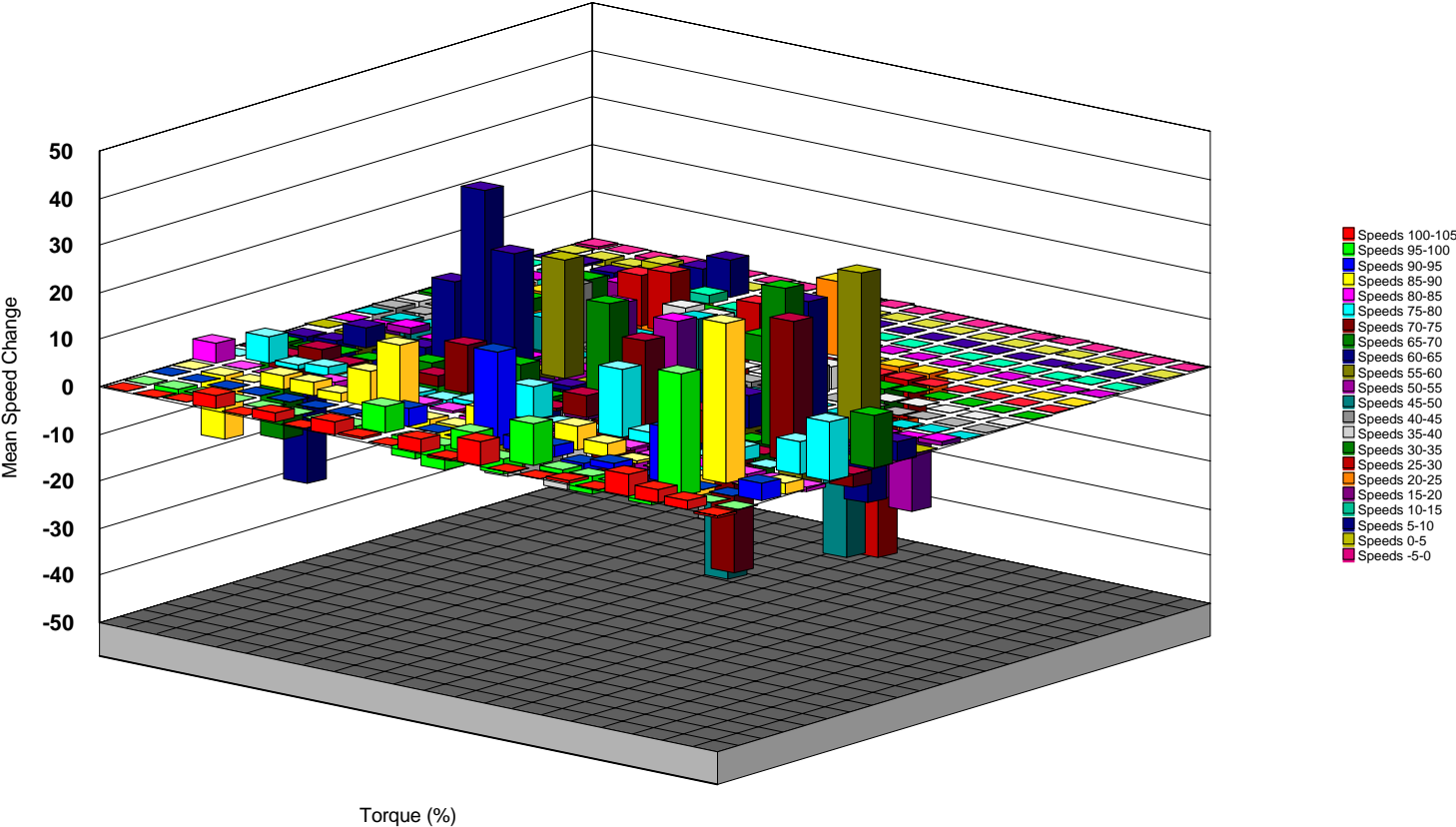
A 3D bar chart illustrating the Standard Deviations (Y-axis, ranging from 0 to 2) across different Torque (%) values (X-axis, ranging from 0 to 100). The Z-axis represents various conditions, color-coded as follows: Yellow (0-20%), Orange (20-40%), Red (40-60%), Green (60-80%), Blue (80-100%), and Purple (100-120%). The chart shows that standard deviations generally increase with torque, with the highest values observed in the 80-100% torque range for the Red and Green conditions.



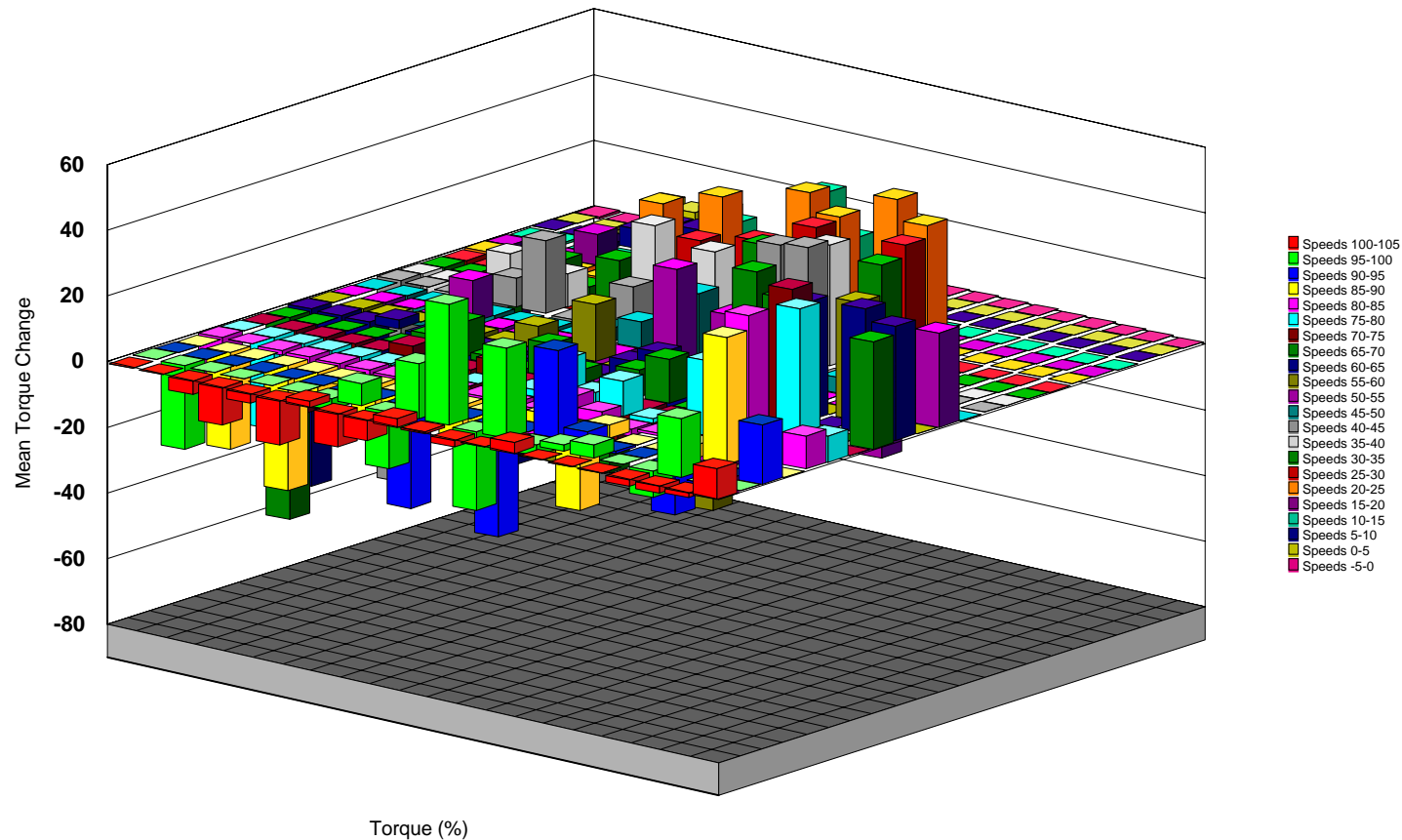
Nonroad Cycle-- Counts



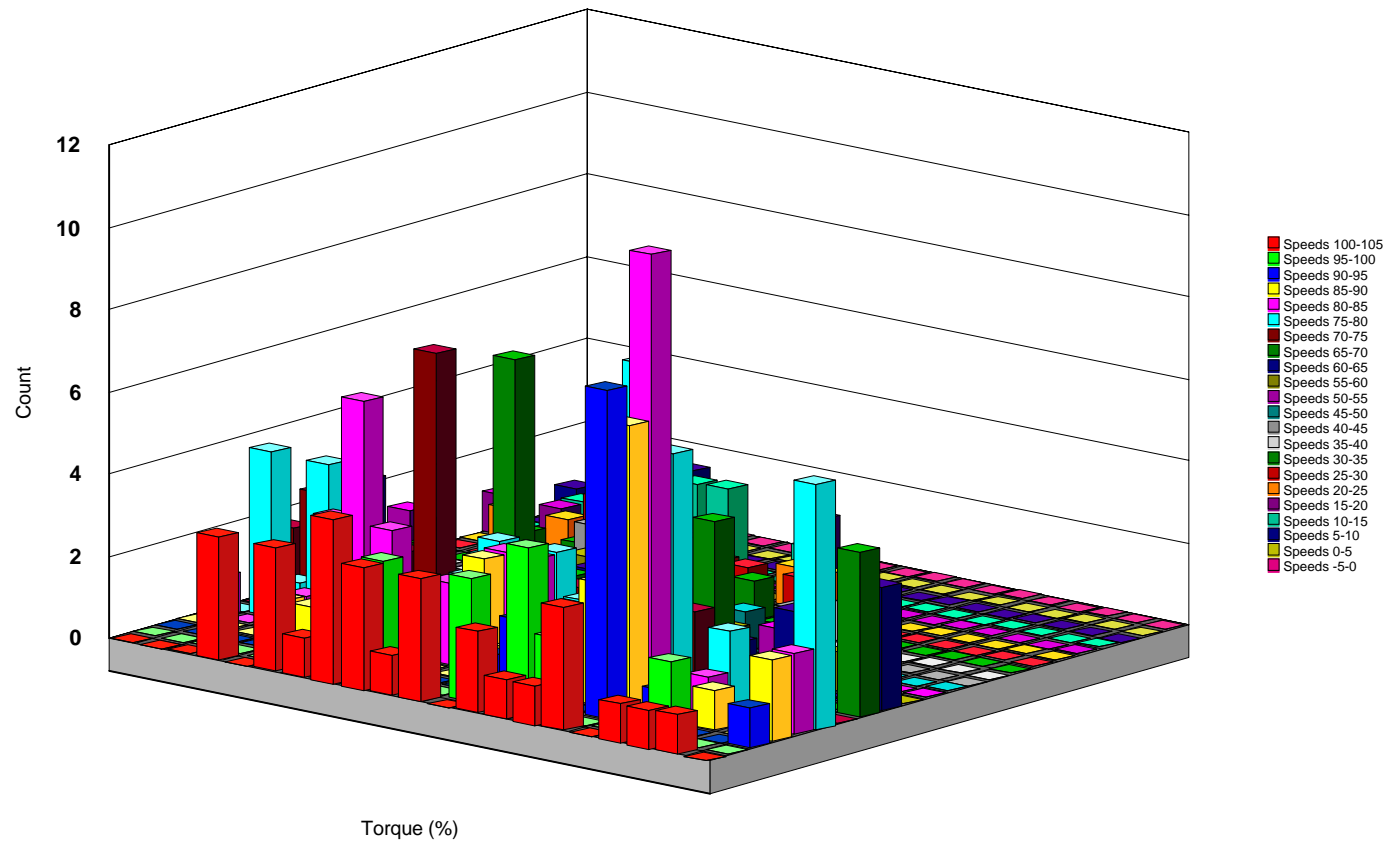
Nonroad Cycle-- Mean Speed Changes



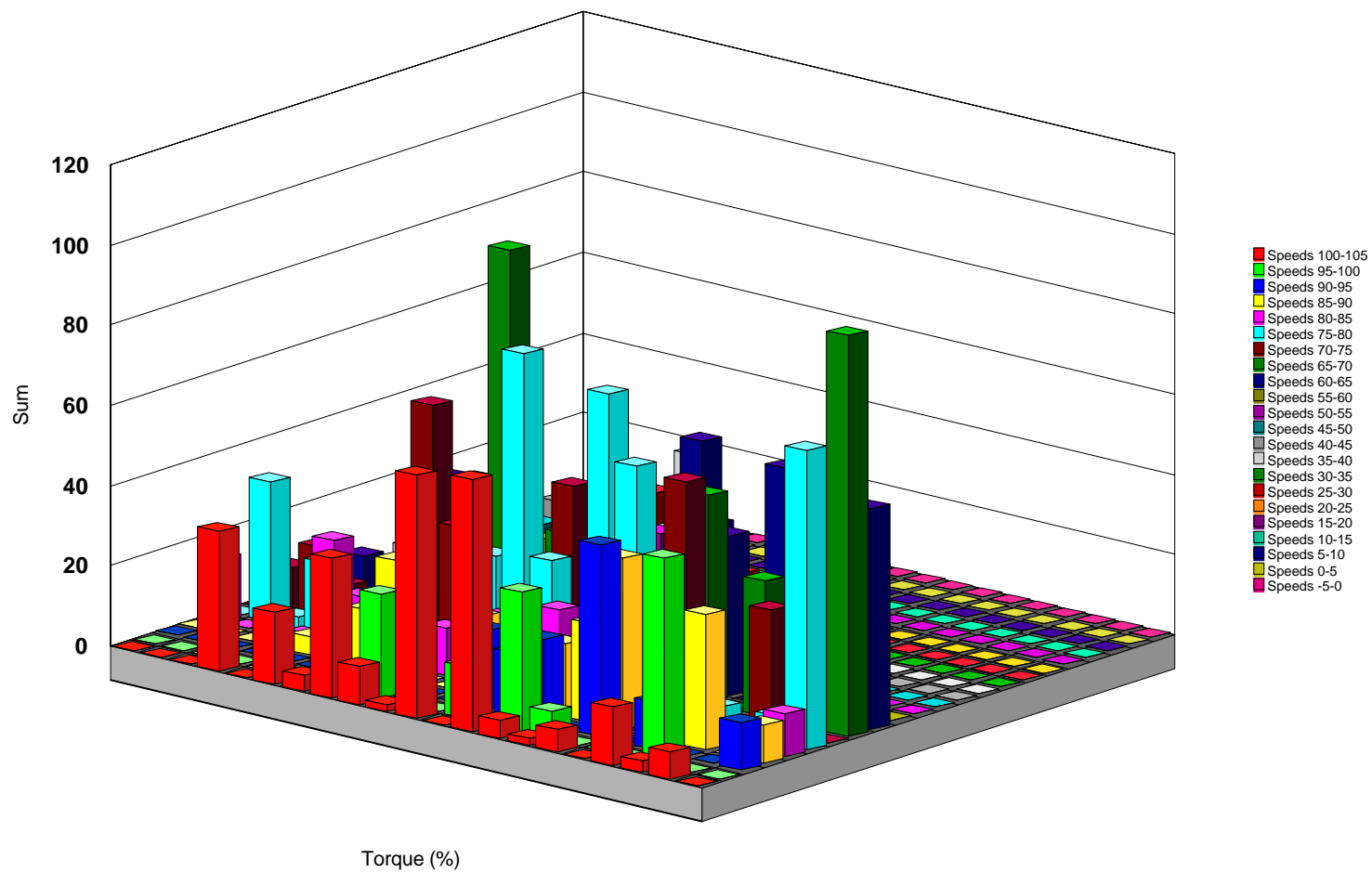
# Nonroad Cycle-- Mean Torque Changes



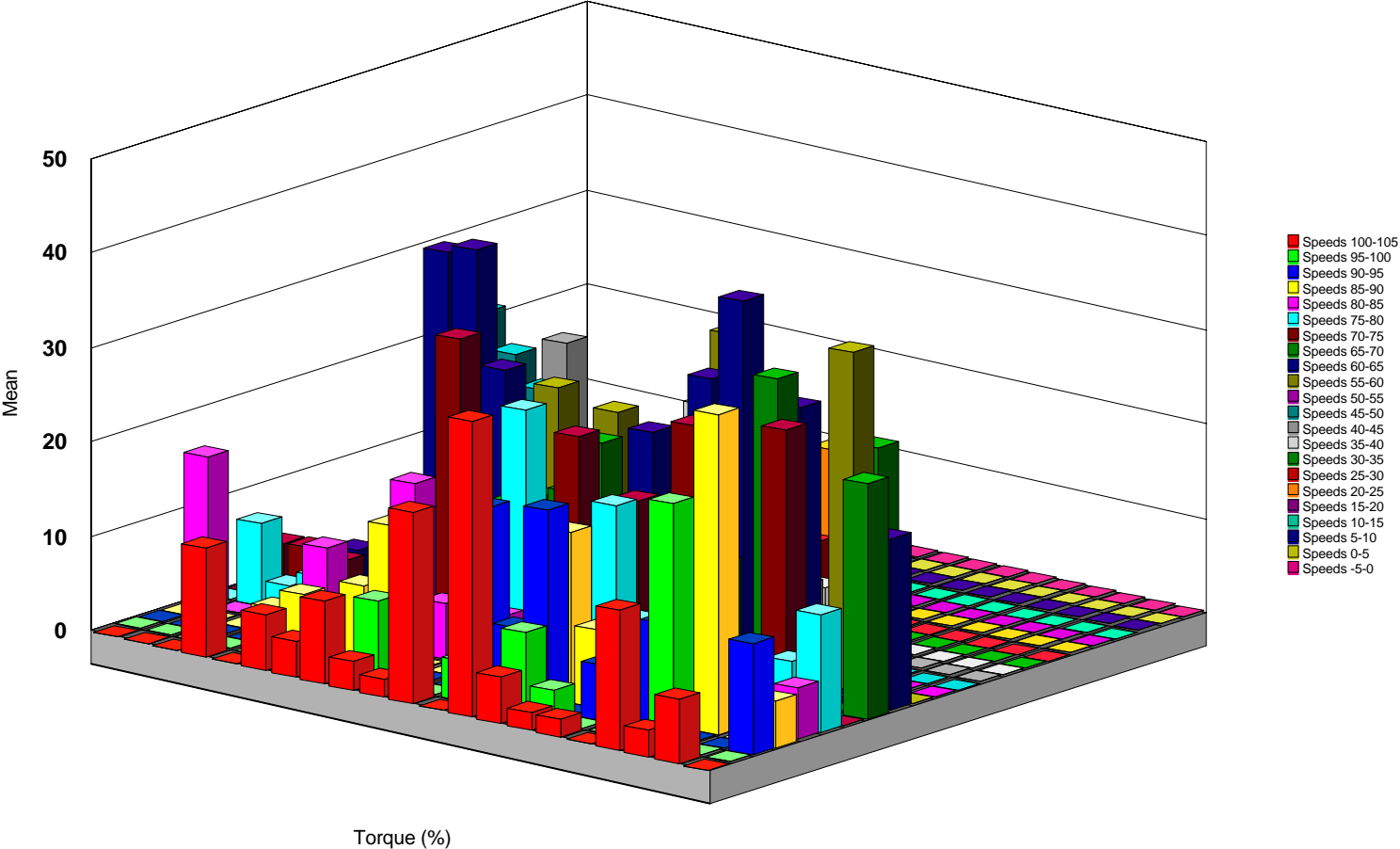
## Nonroad Cycle-- Speed Acceleration Counts



## Nonroad Cycle--Speed Acceleration Sums

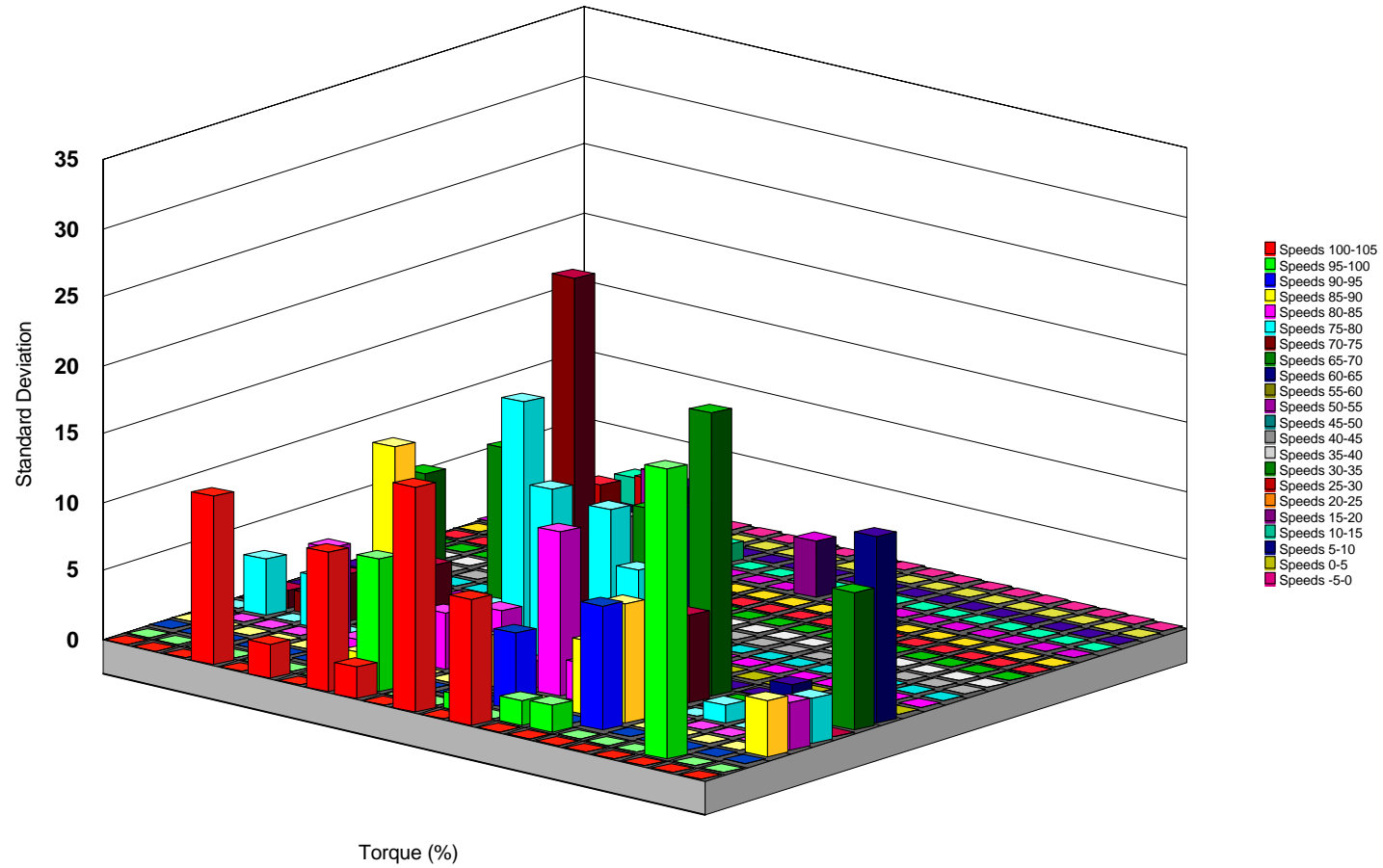


Nonroad Cycle--Speed Acceleration Means

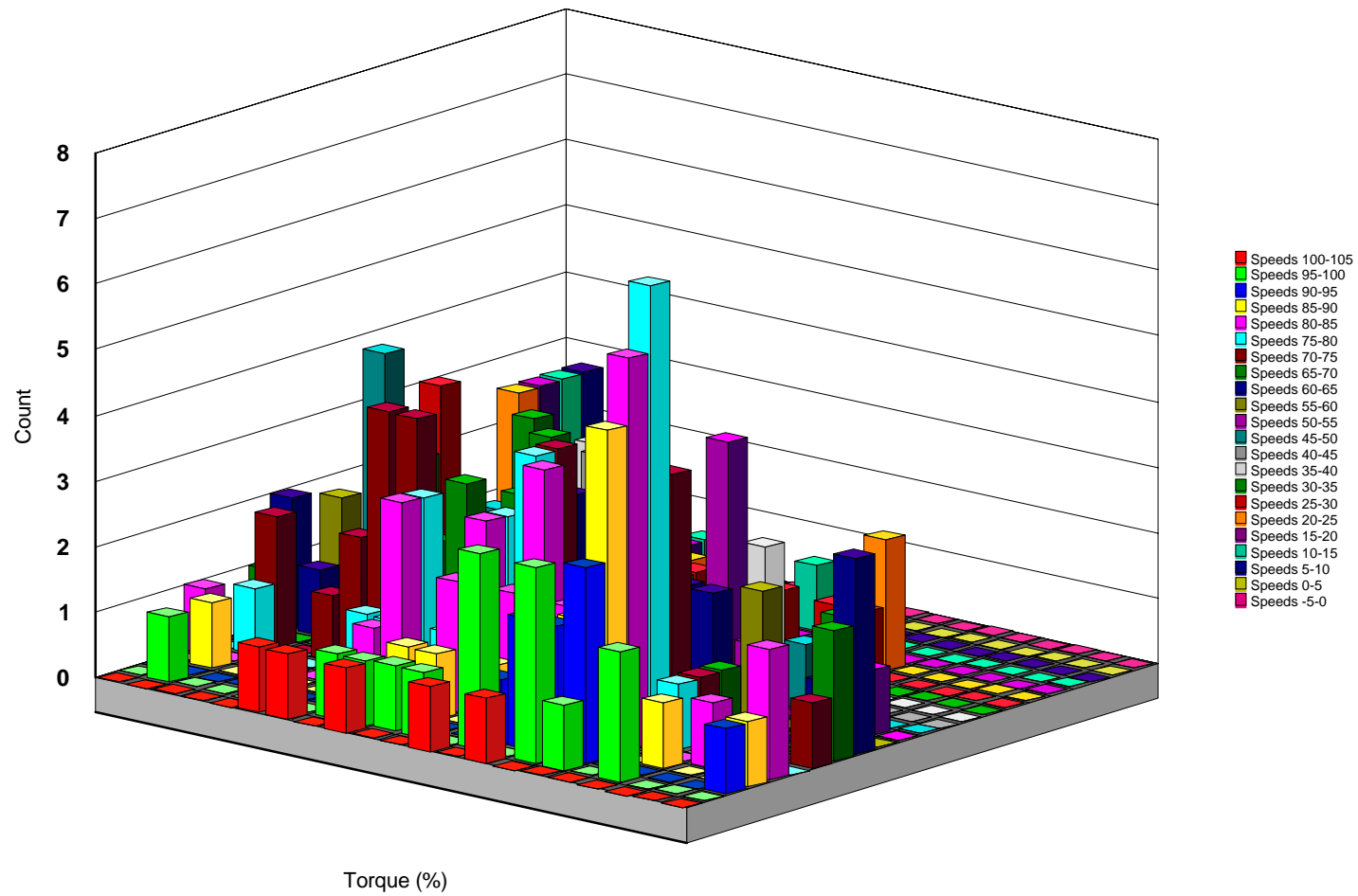




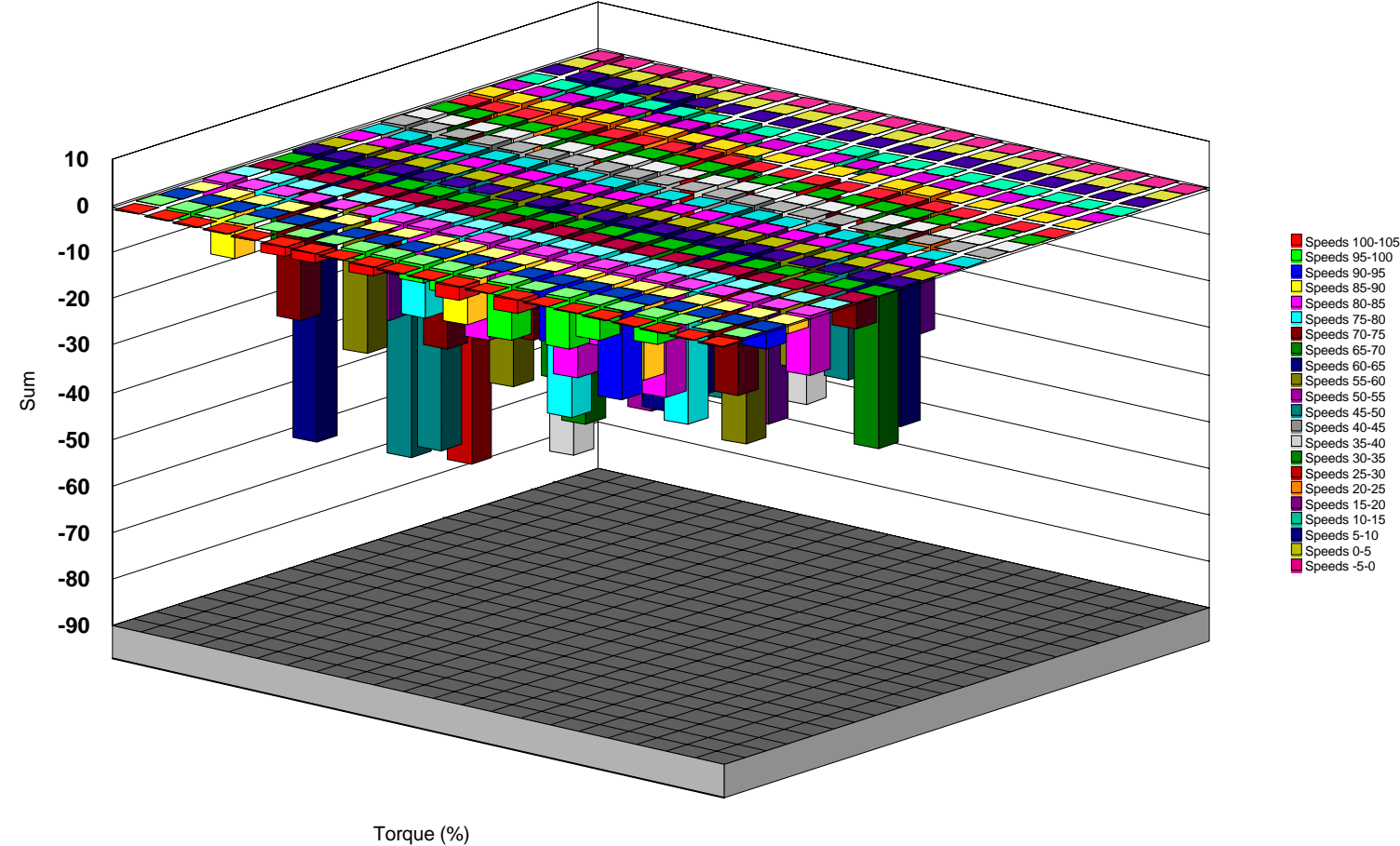
## Nonroad Cycle--Speed Acceleration Standard Deviations



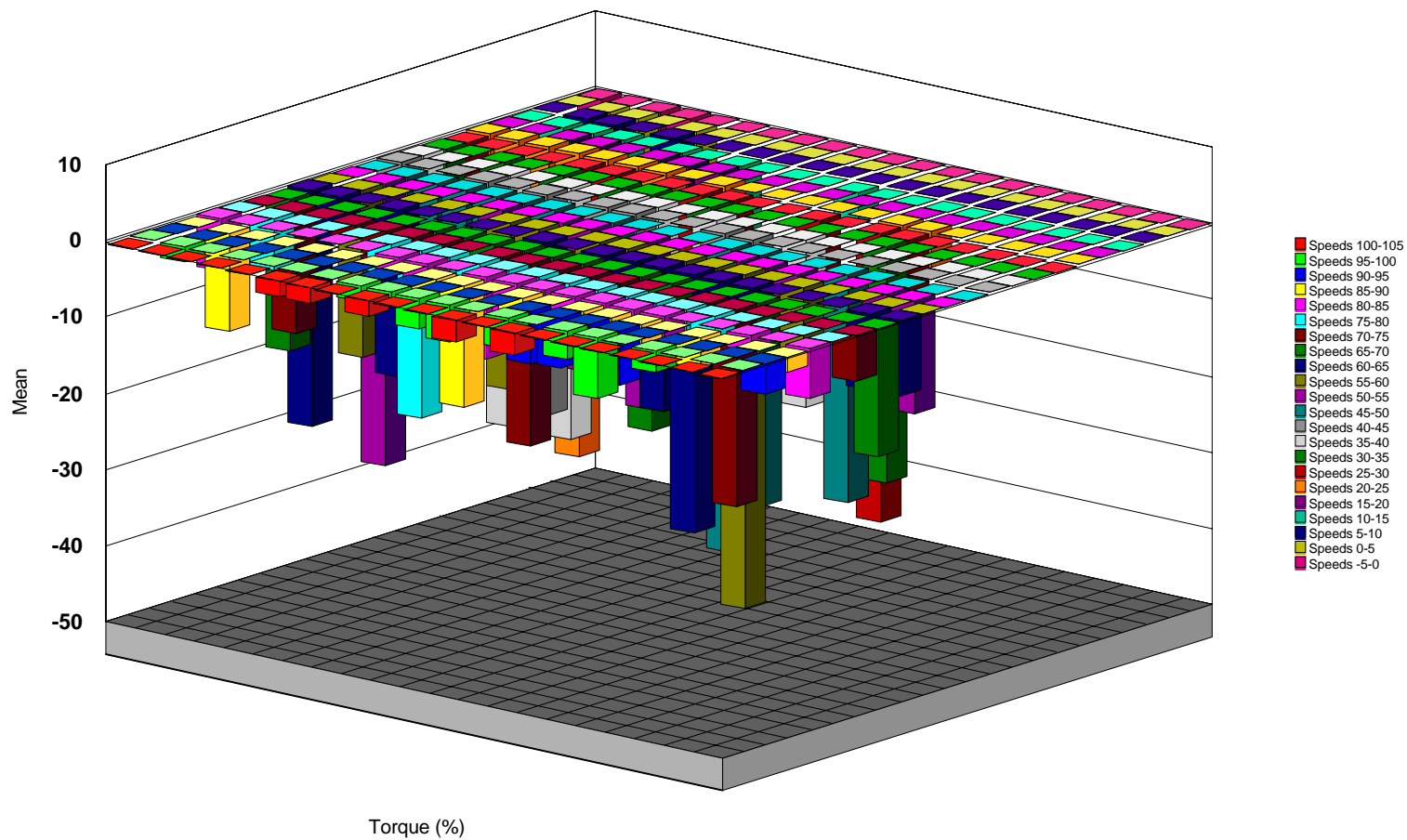
## Nonroad Cycle--Speed Deceleration Counts



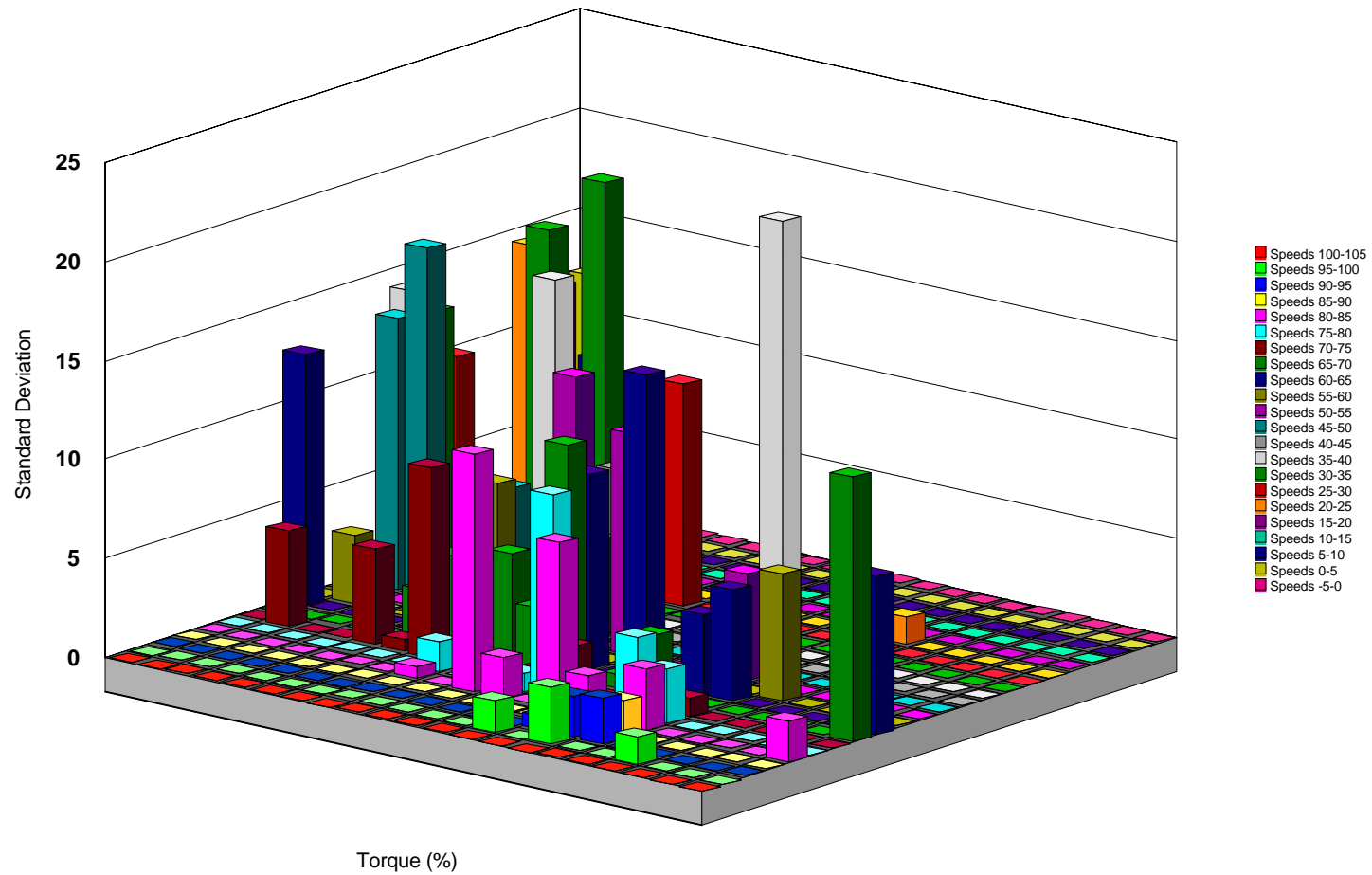
Nonroad Cycle--Speed Deceleration Sums



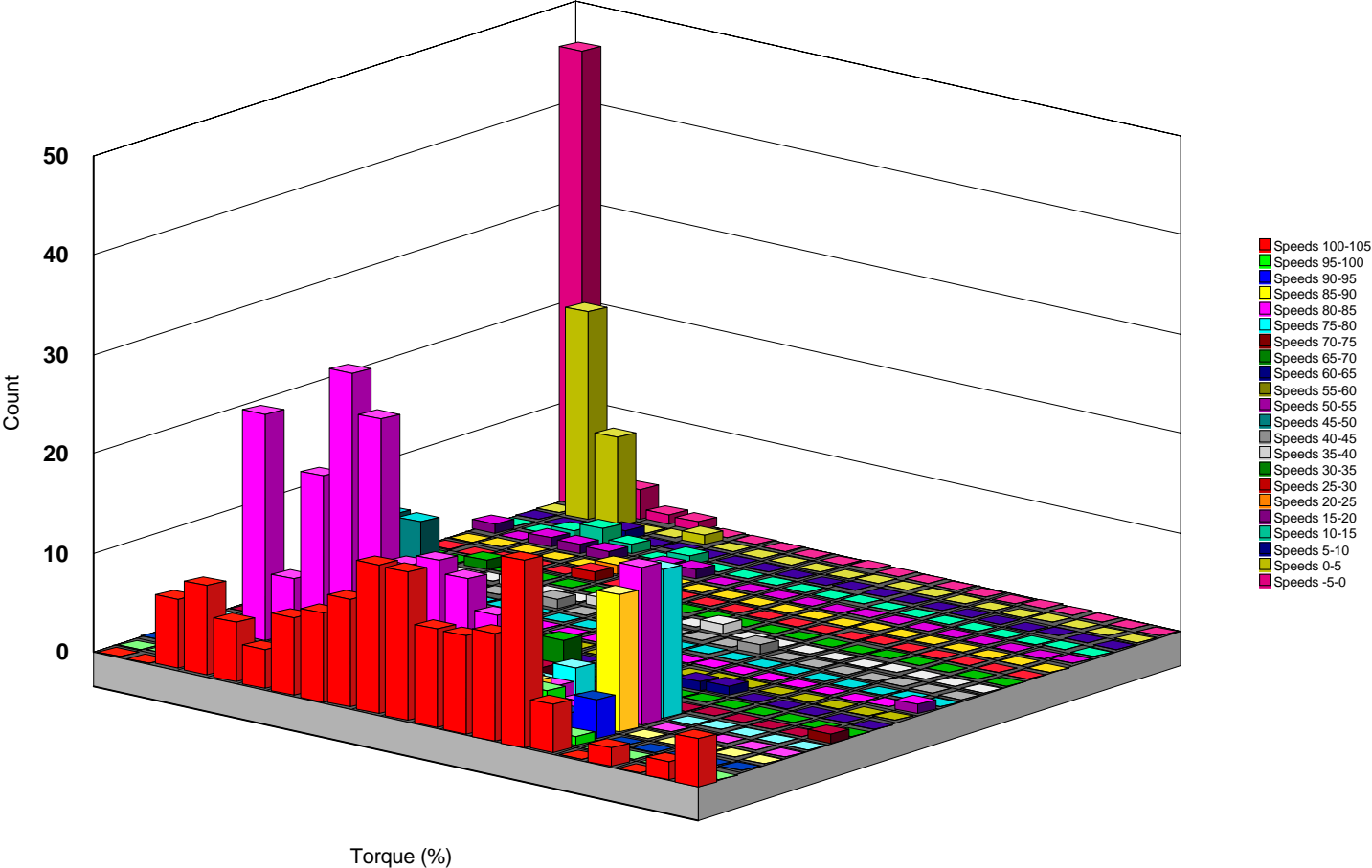
## Nonroad Cycle--Speed Deceleration Means



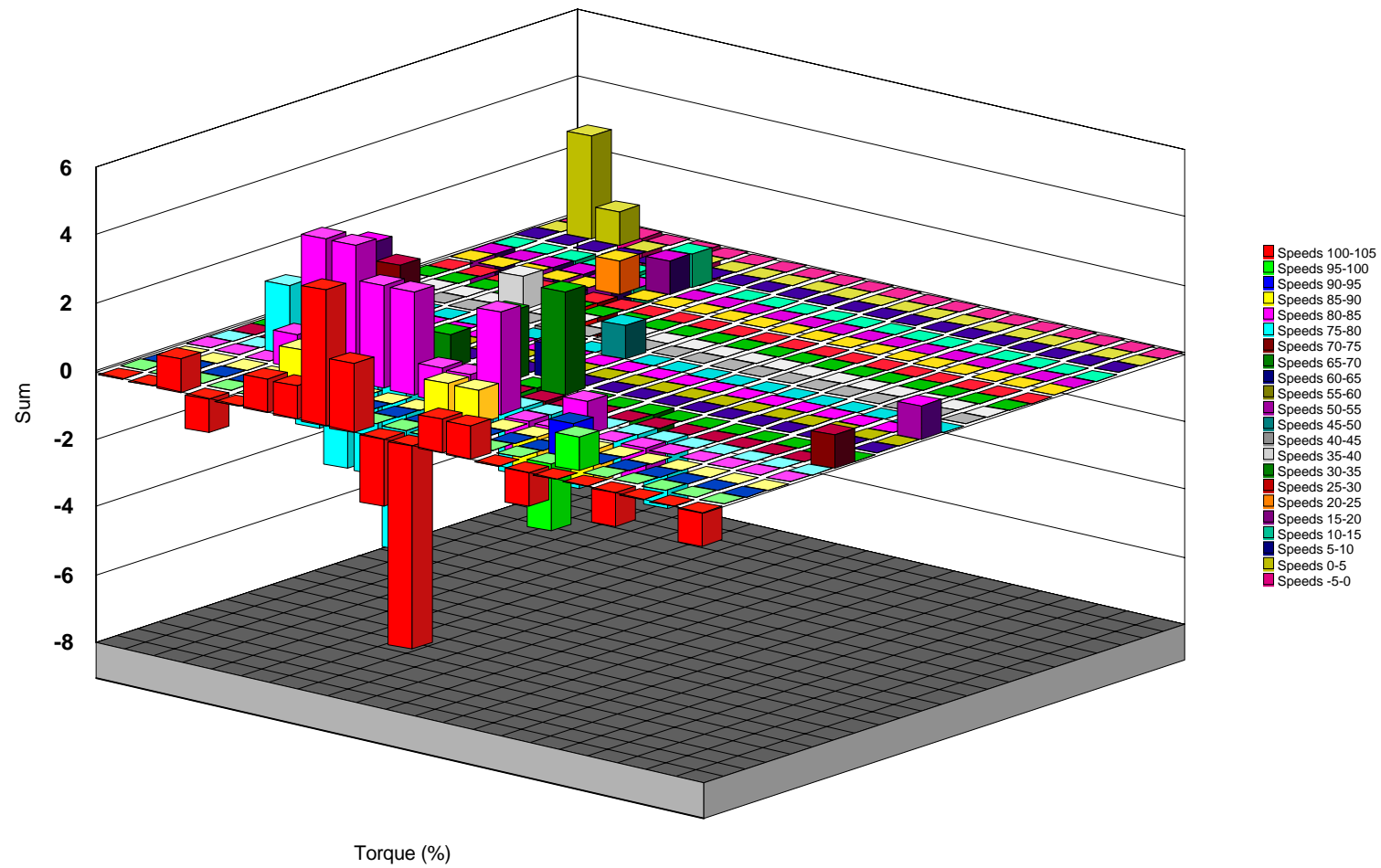
## Nonroad Cycle--Speed Deceleration Standard Deviations



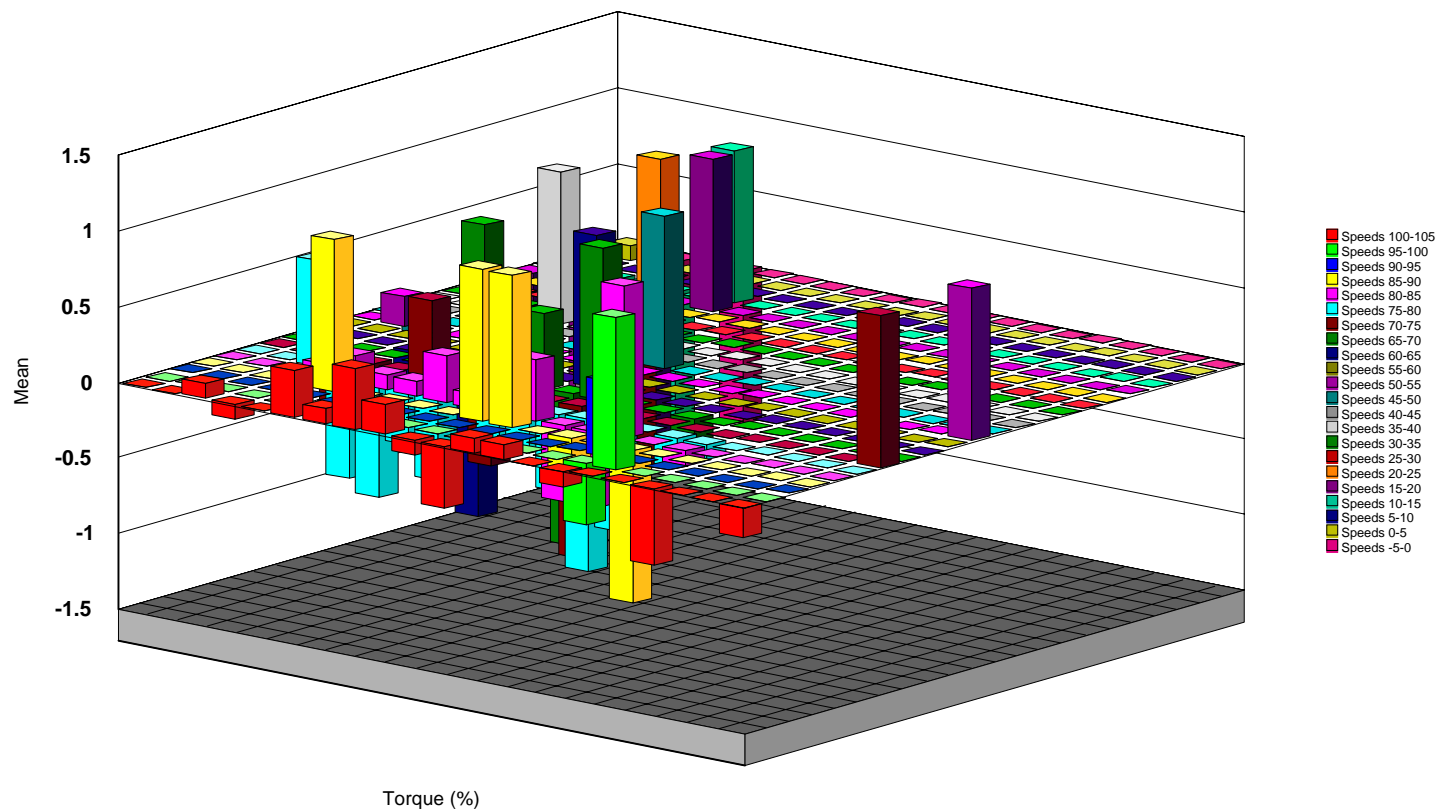
Nonroad Cycle--Speed Steady State Counts



## Nonroad Cycle--Speed Steady State Sums



## Nonroad Cycle--Speed Steady State Means

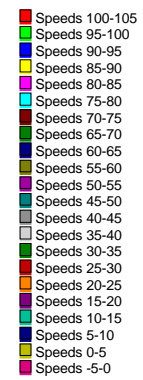




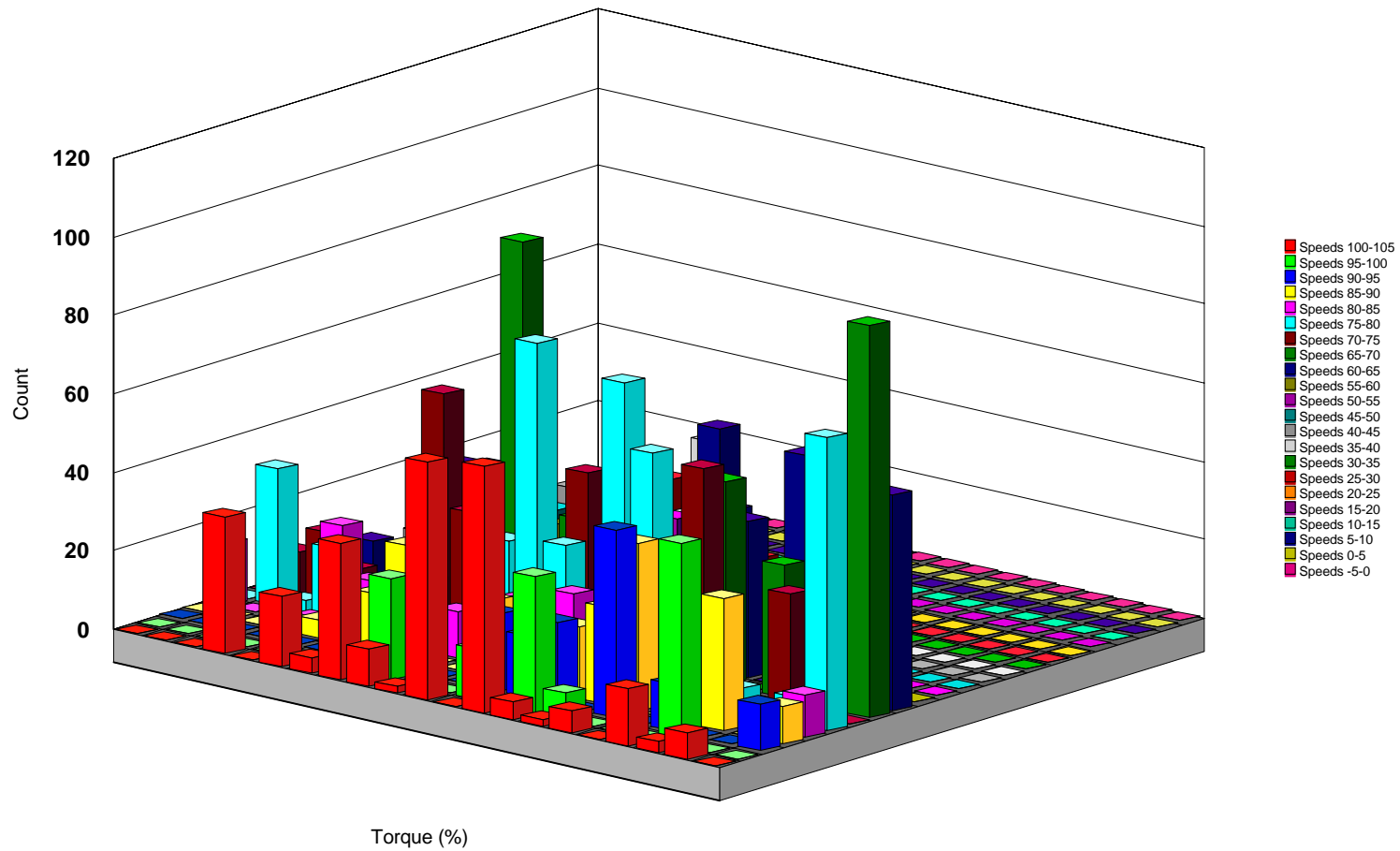
Standard Deviation

Torque (%)

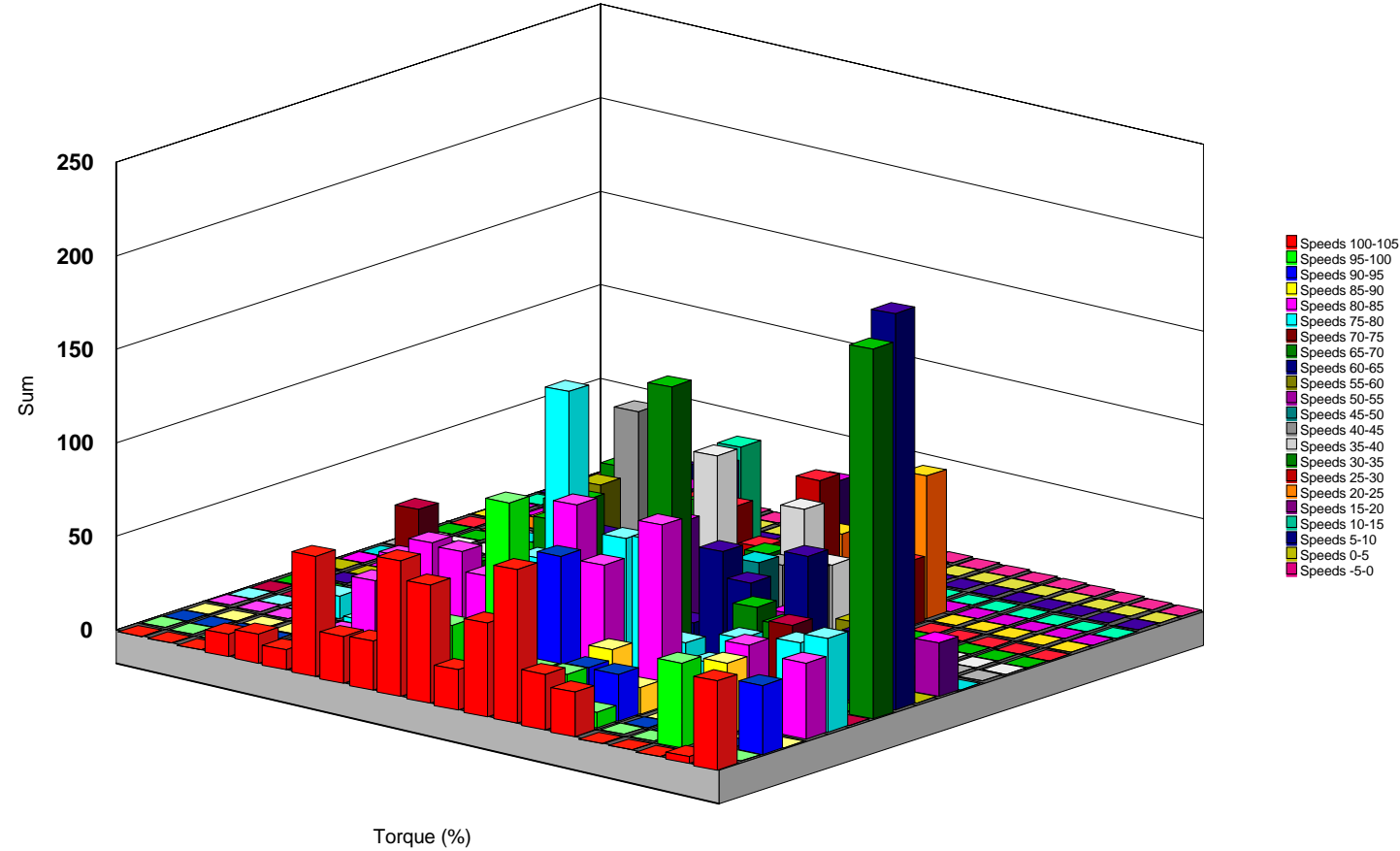
- Speeds 100-105
- Speeds 95-100
- Speeds 90-95
- Speeds 85-90
- Speeds 80-85
- Speeds 75-80
- Speeds 70-75
- Speeds 65-70
- Speeds 60-65
- Speeds 55-60
- Speeds 50-55
- Speeds 45-50
- Speeds 40-45
- Speeds 35-40
- Speeds 30-35
- Speeds 25-30
- Speeds 20-25
- Speeds 15-20
- Speeds 10-15
- Speeds 5-10
- Speeds 0-5
- Speeds -5-0



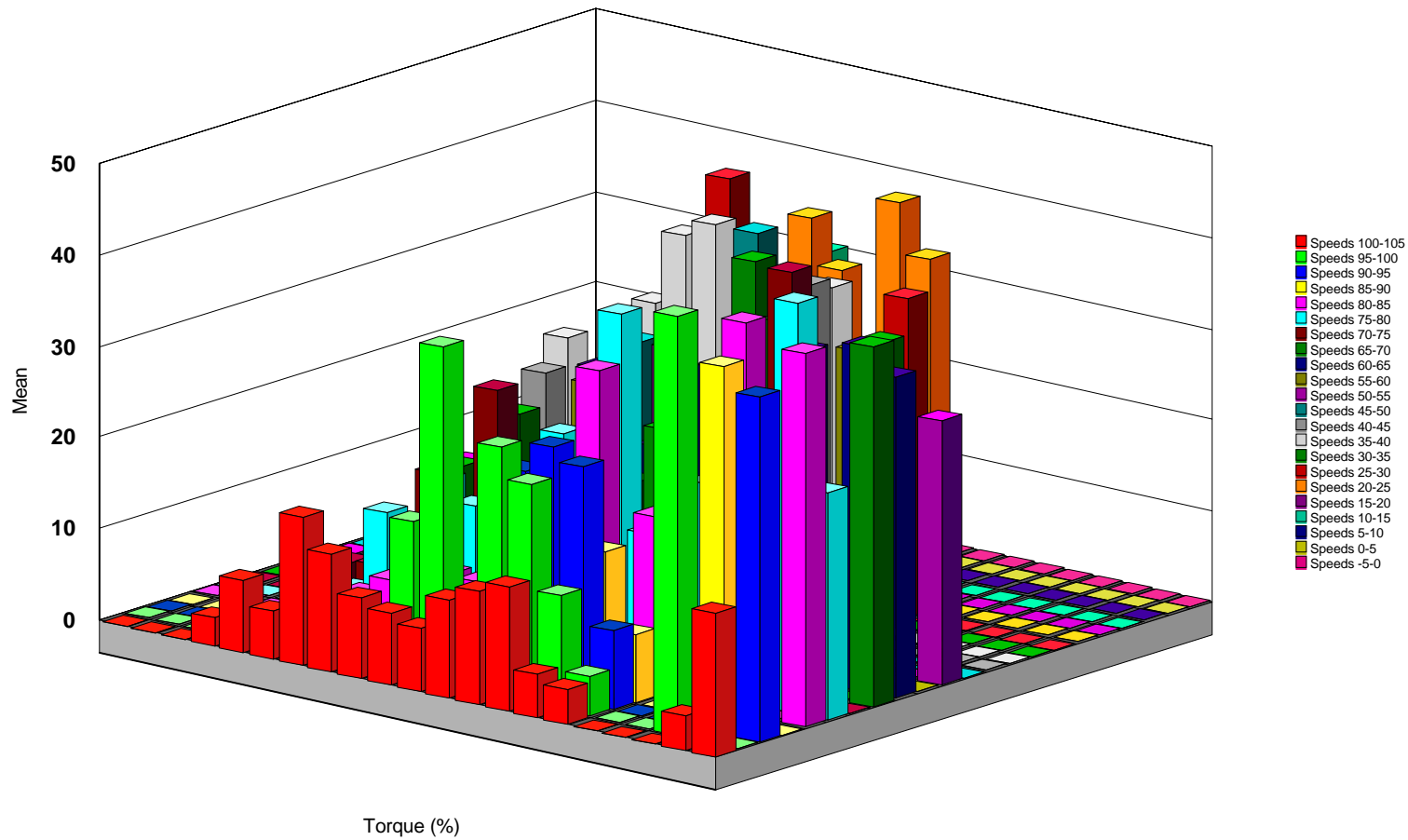
## Nonroad Cycle--Torque Acceleration Counts



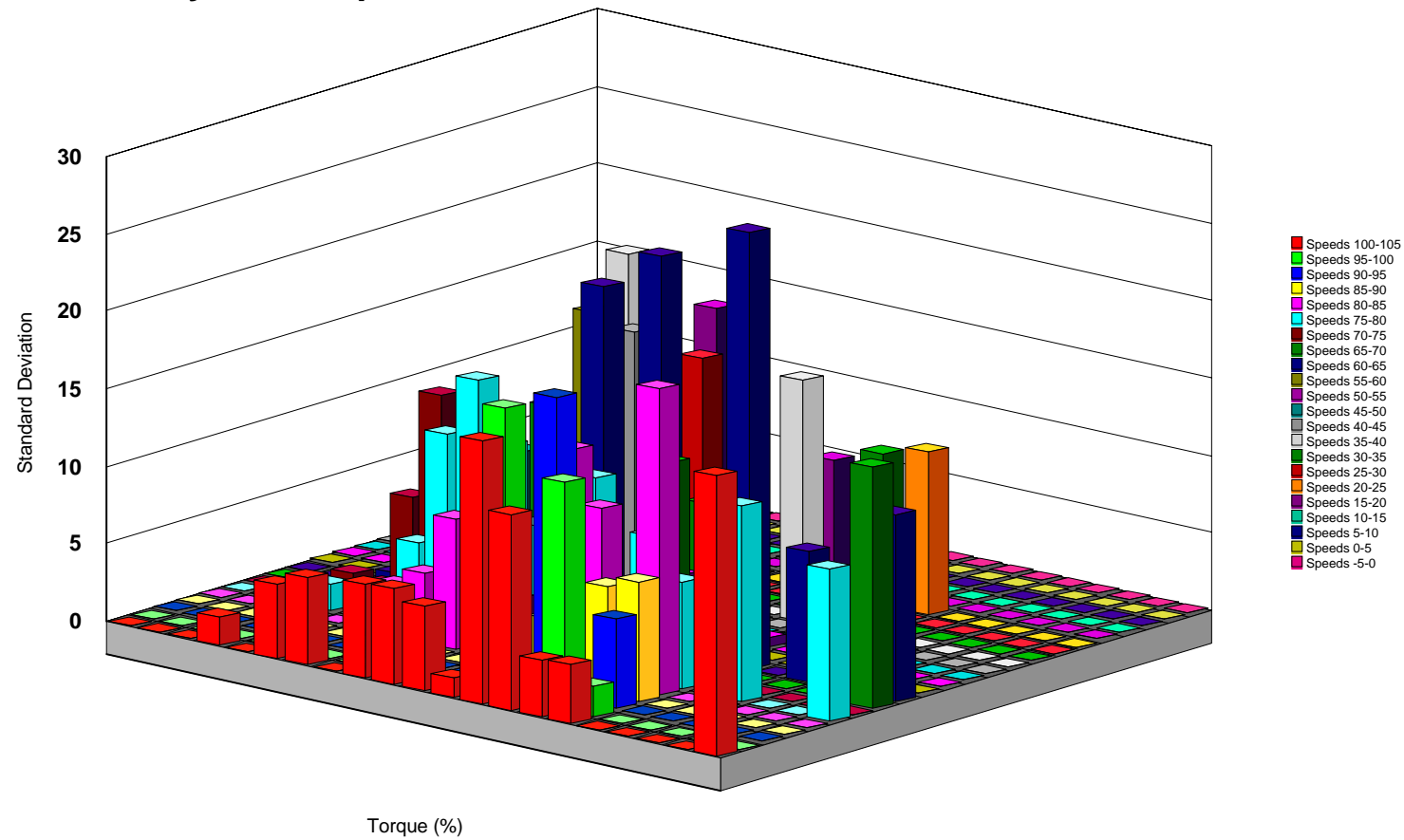
Nonroad Cycle--Torque Acceleration Sums



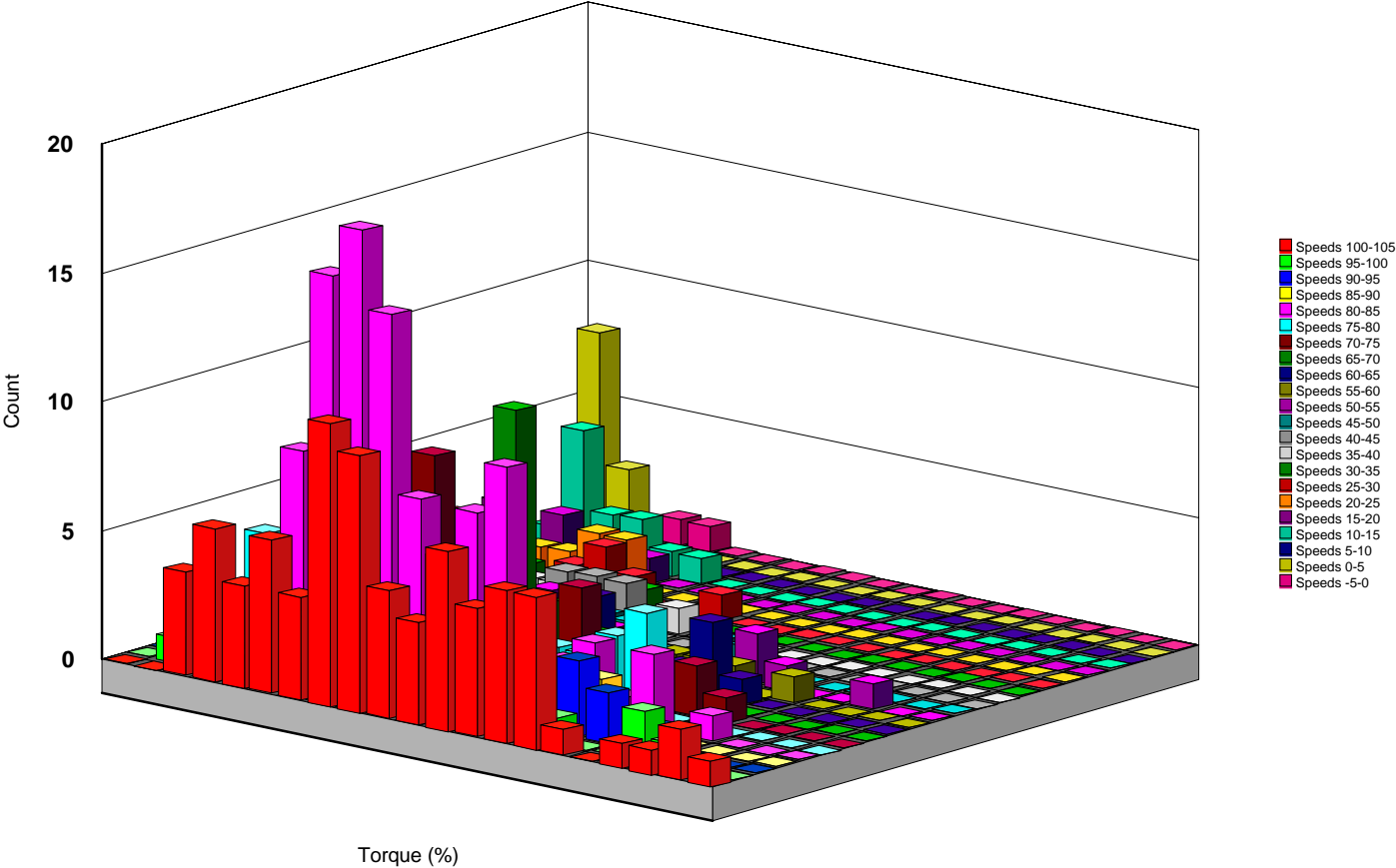
## Nonroad Cycle--Torque Acceleration Means



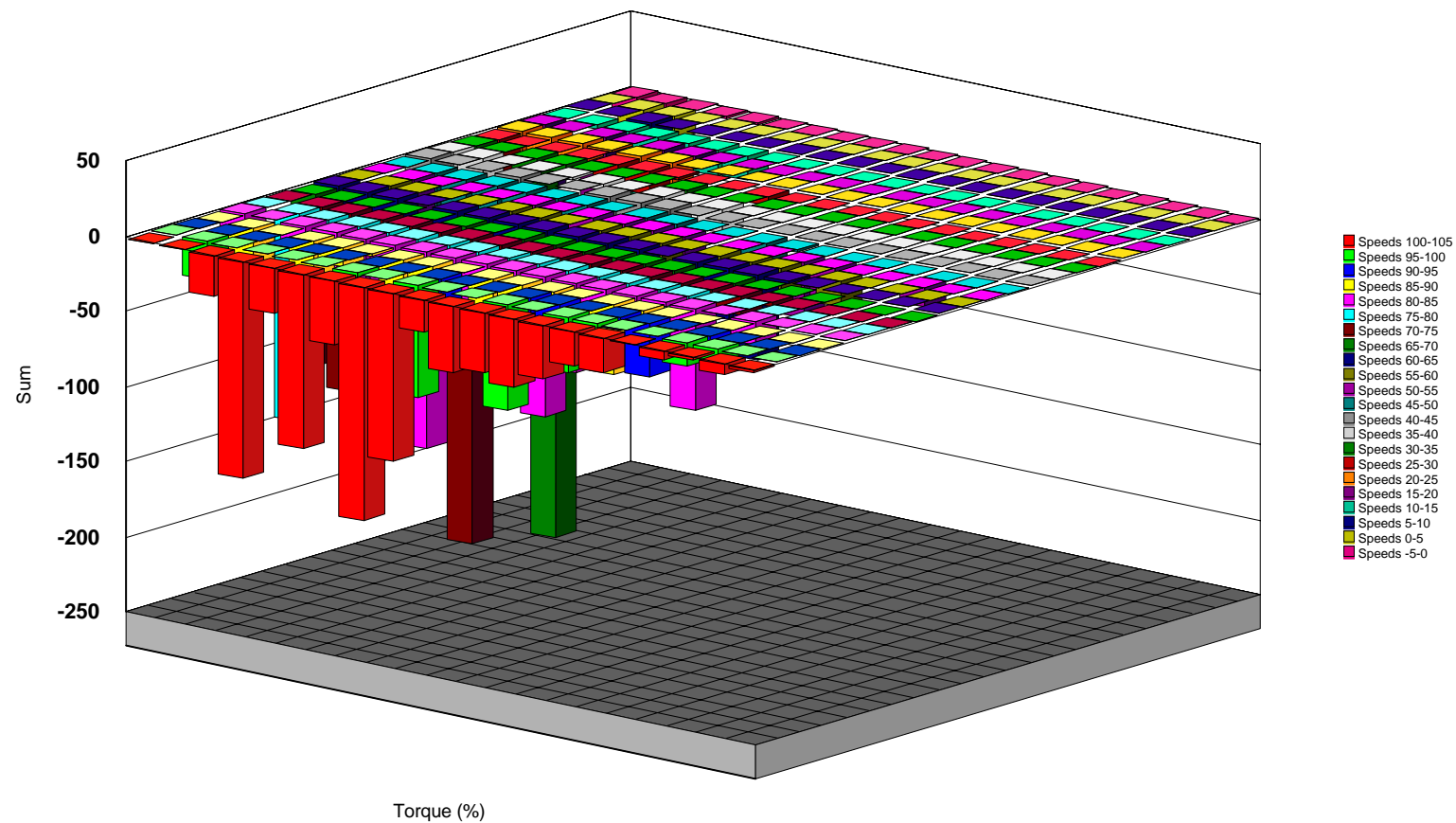
## Nonroad Cycle--Torque Acceleration Standard Deviations



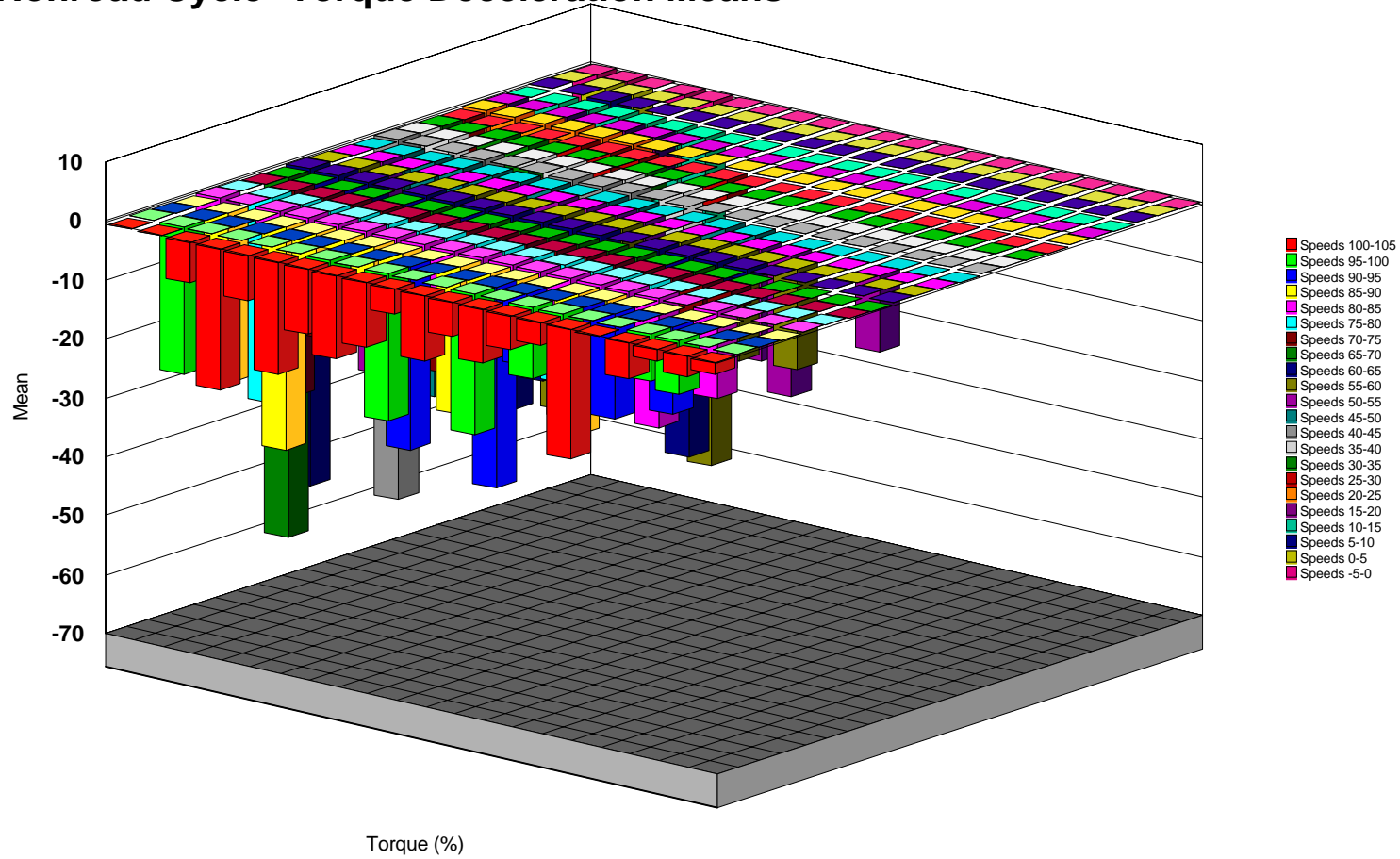
# Nonroad Cycle--Torque Deceleration Counts



## Nonroad Cycle--Torque Deceleration Sums

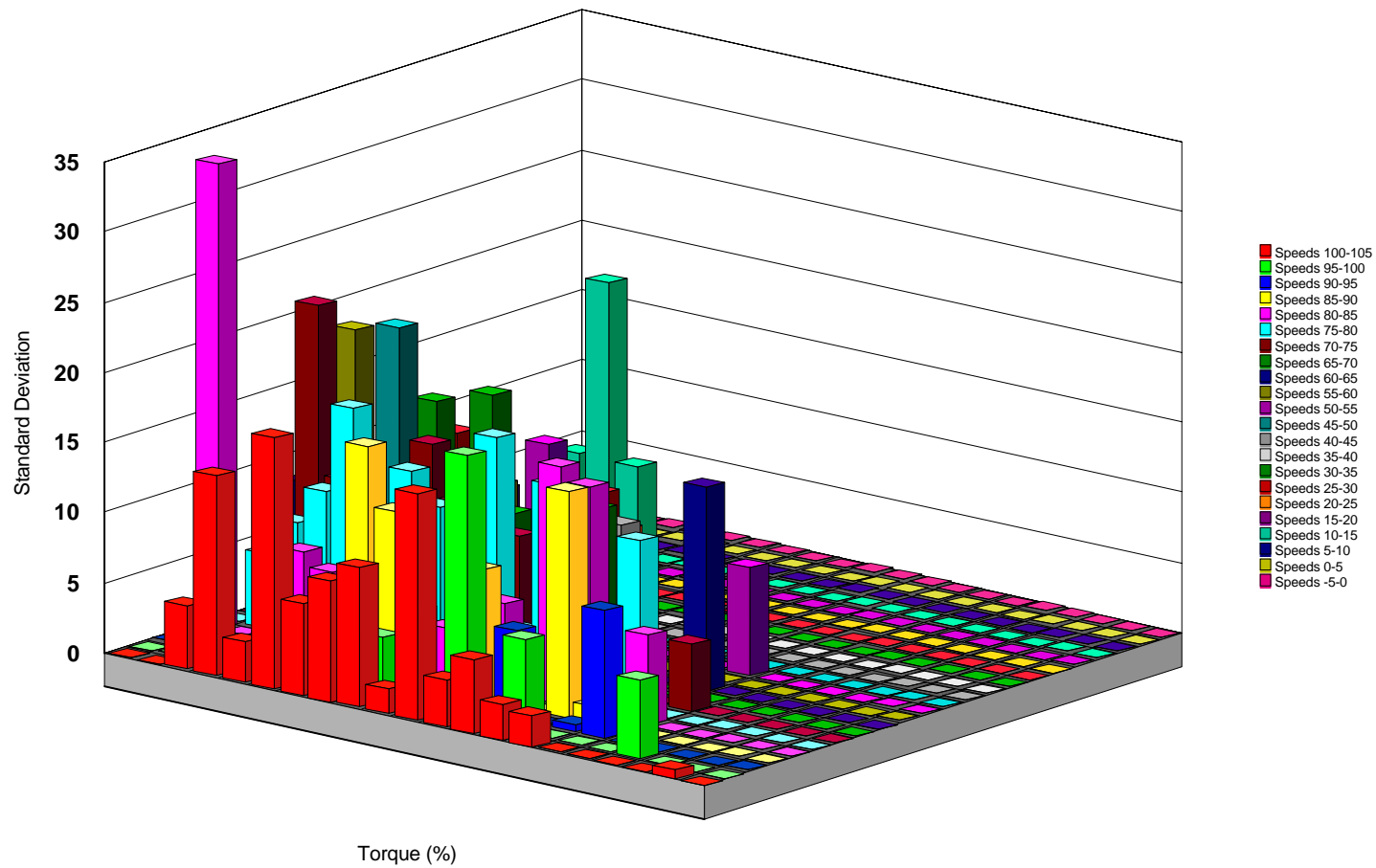


## Nonroad Cycle--Torque Deceleration Means

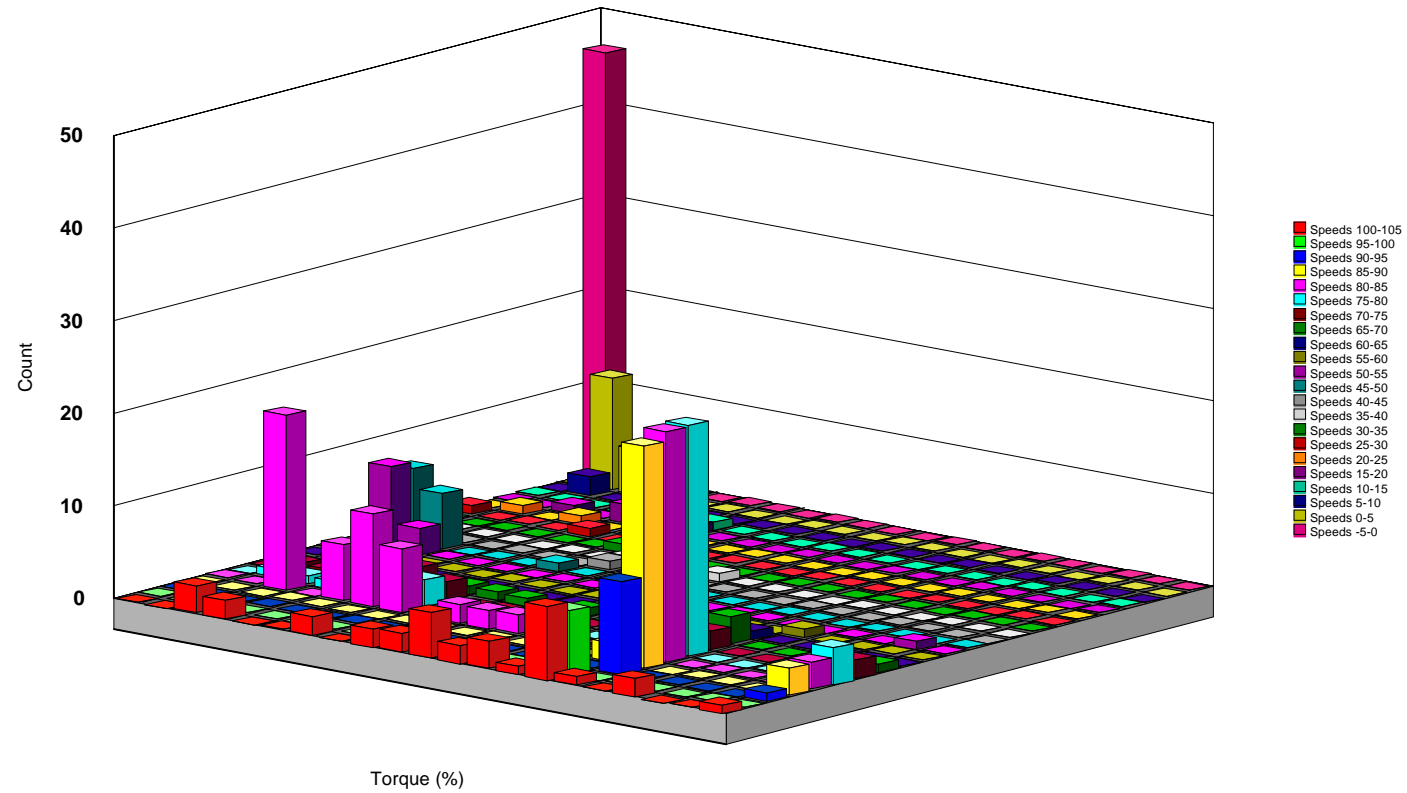




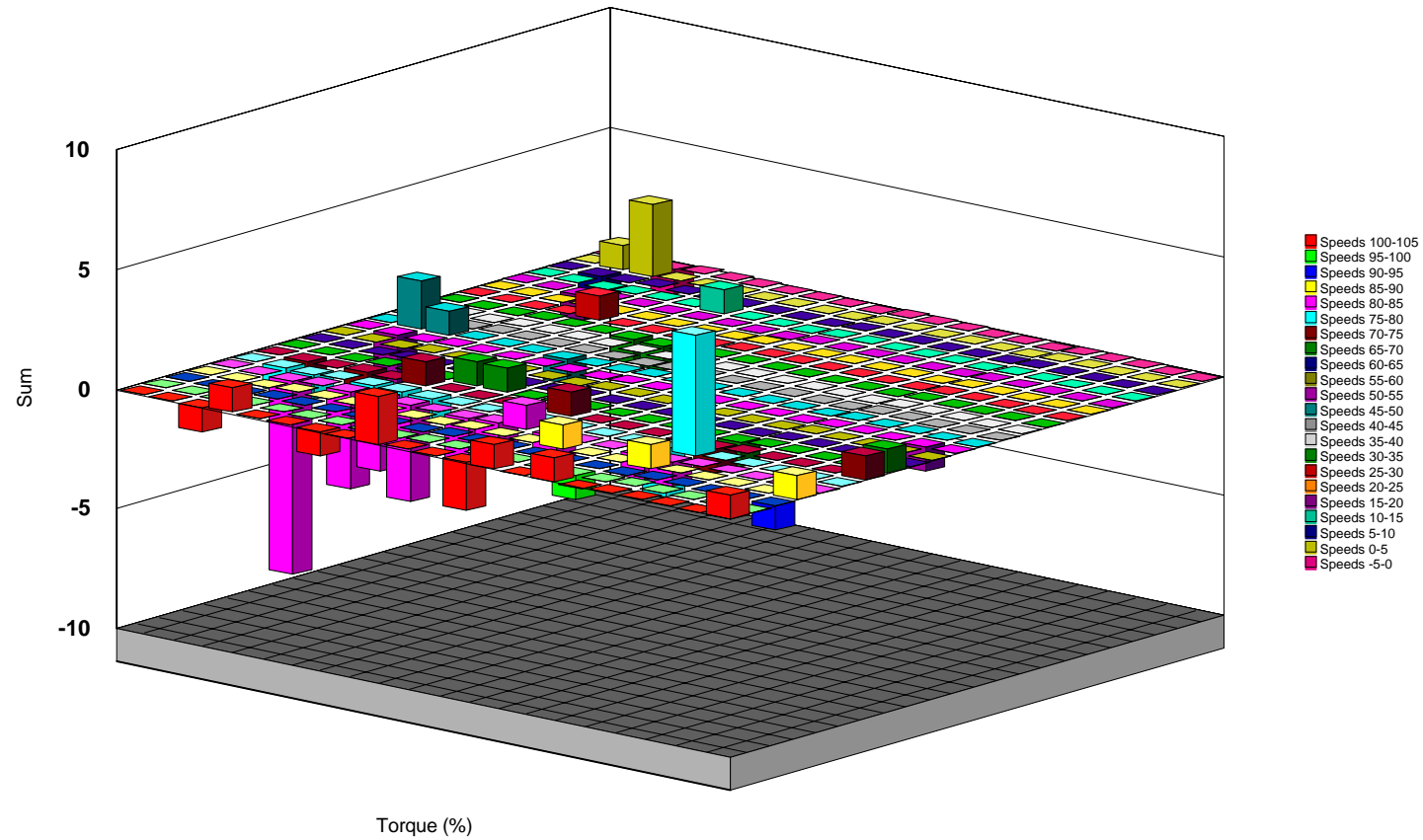
## Nonroad Cycle--Torque Deceleration Standard Deviations



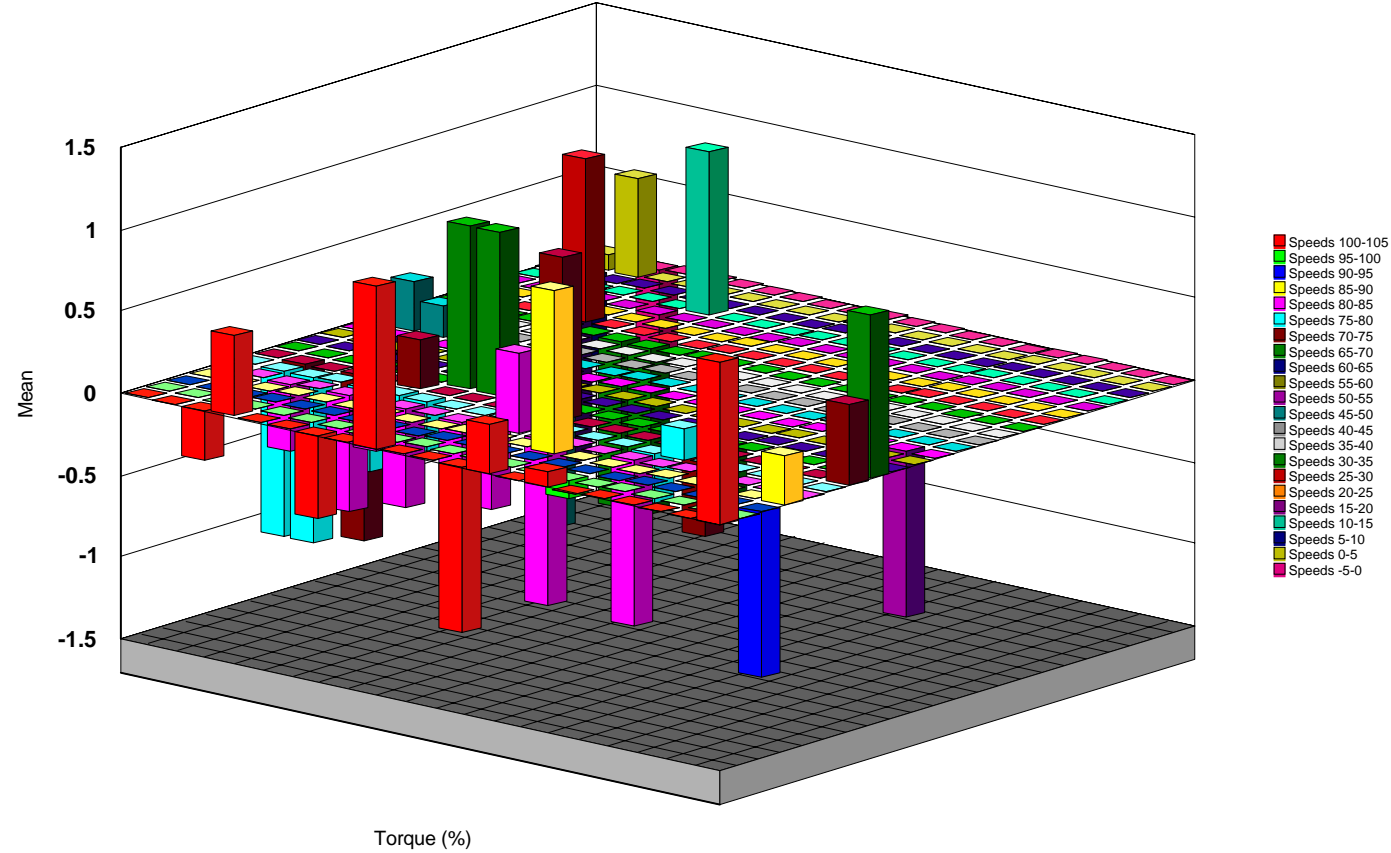
## Nonroad Cycle--Torque Steady State Counts



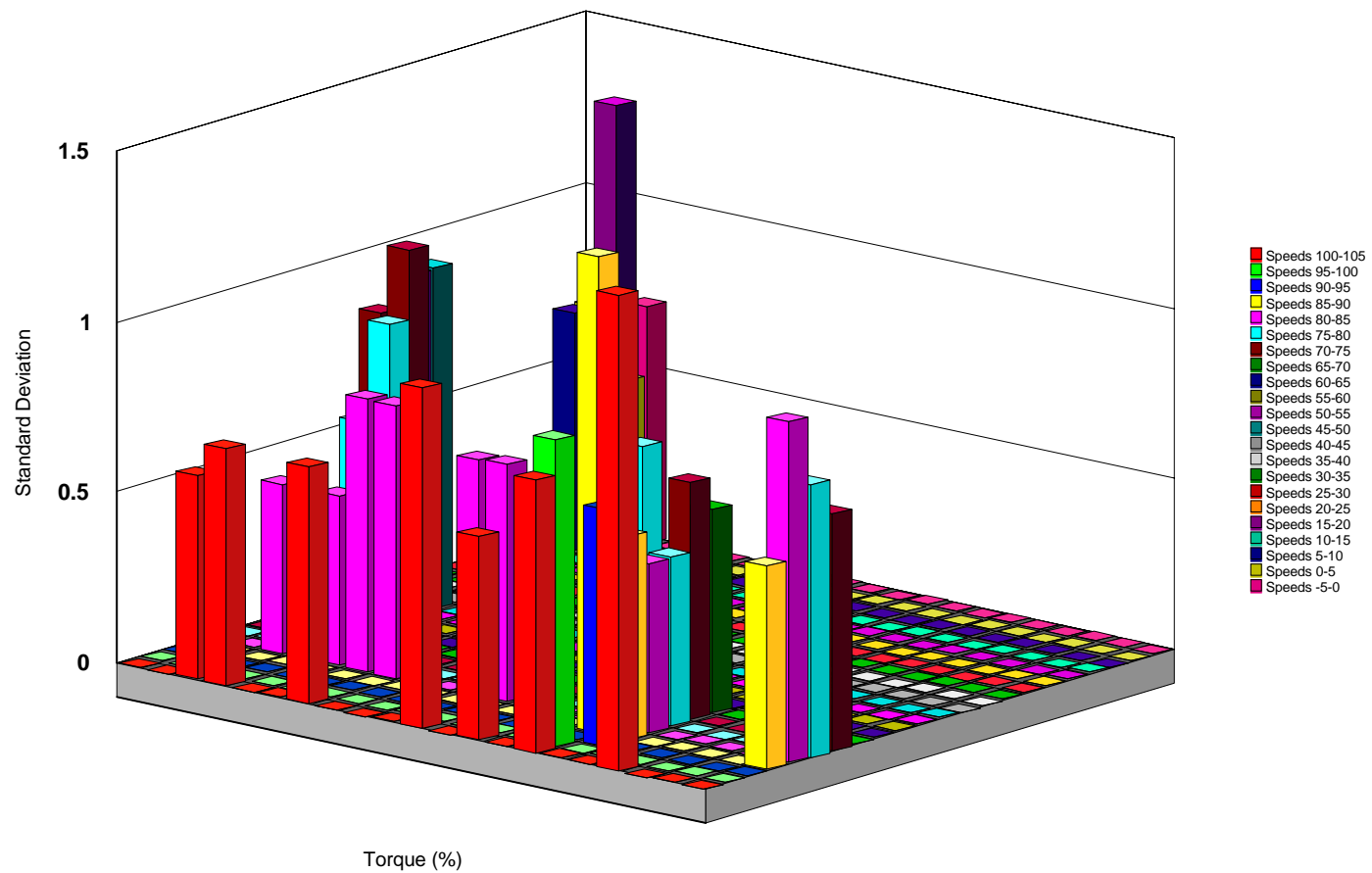
## Nonroad Cycle--Torque Steady State Sums



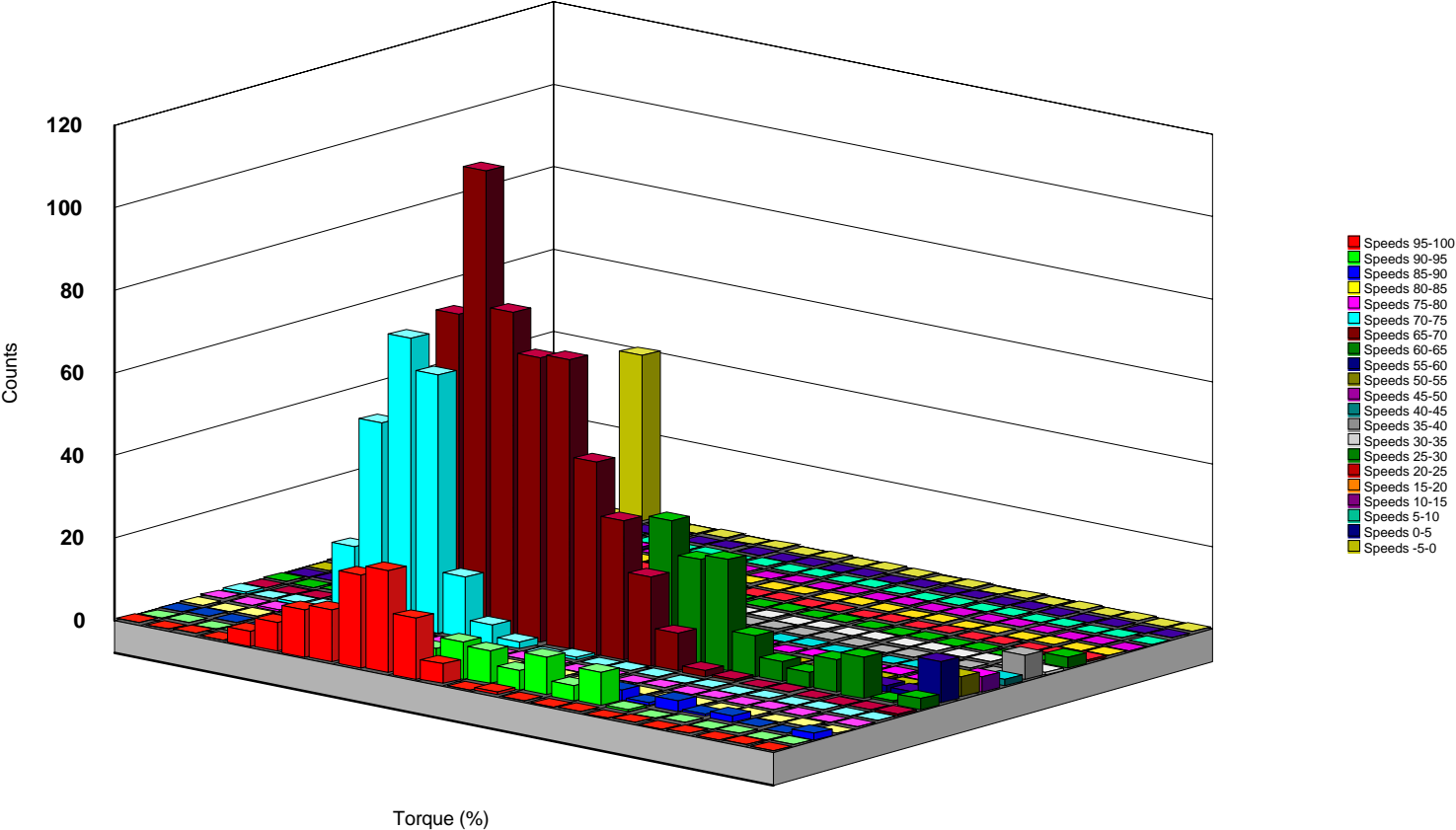
Nonroad Cycle--Torque Steady State Means



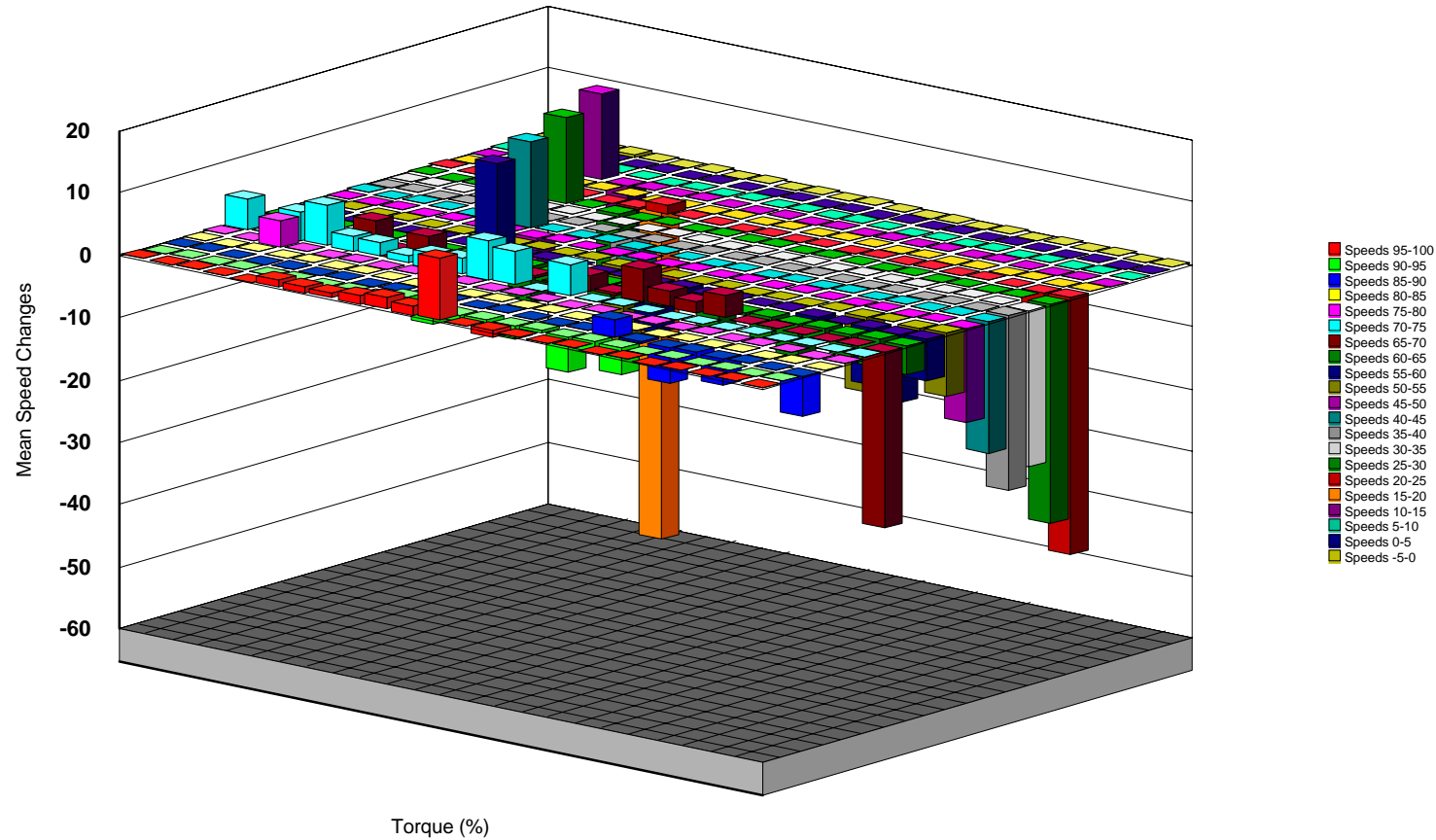
## Nonroad Cycle--Torque Steady State Standard Deviations



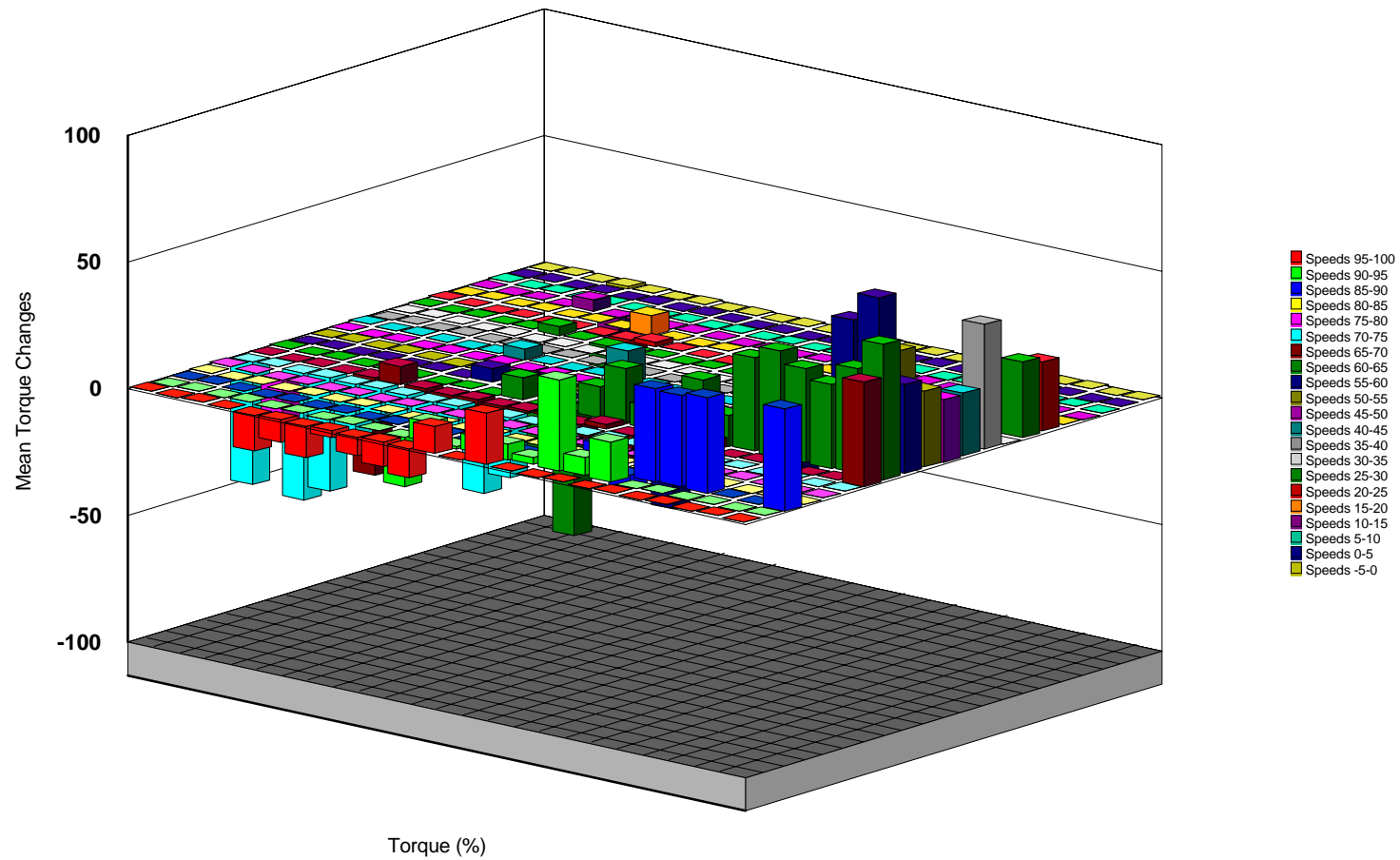
SKID STEER LOADER HIGH TORQUE TRANSIENT--Counts



SKID STEER LOADER HIGH TORQUE TRANSIENT--Mean Speed Changes

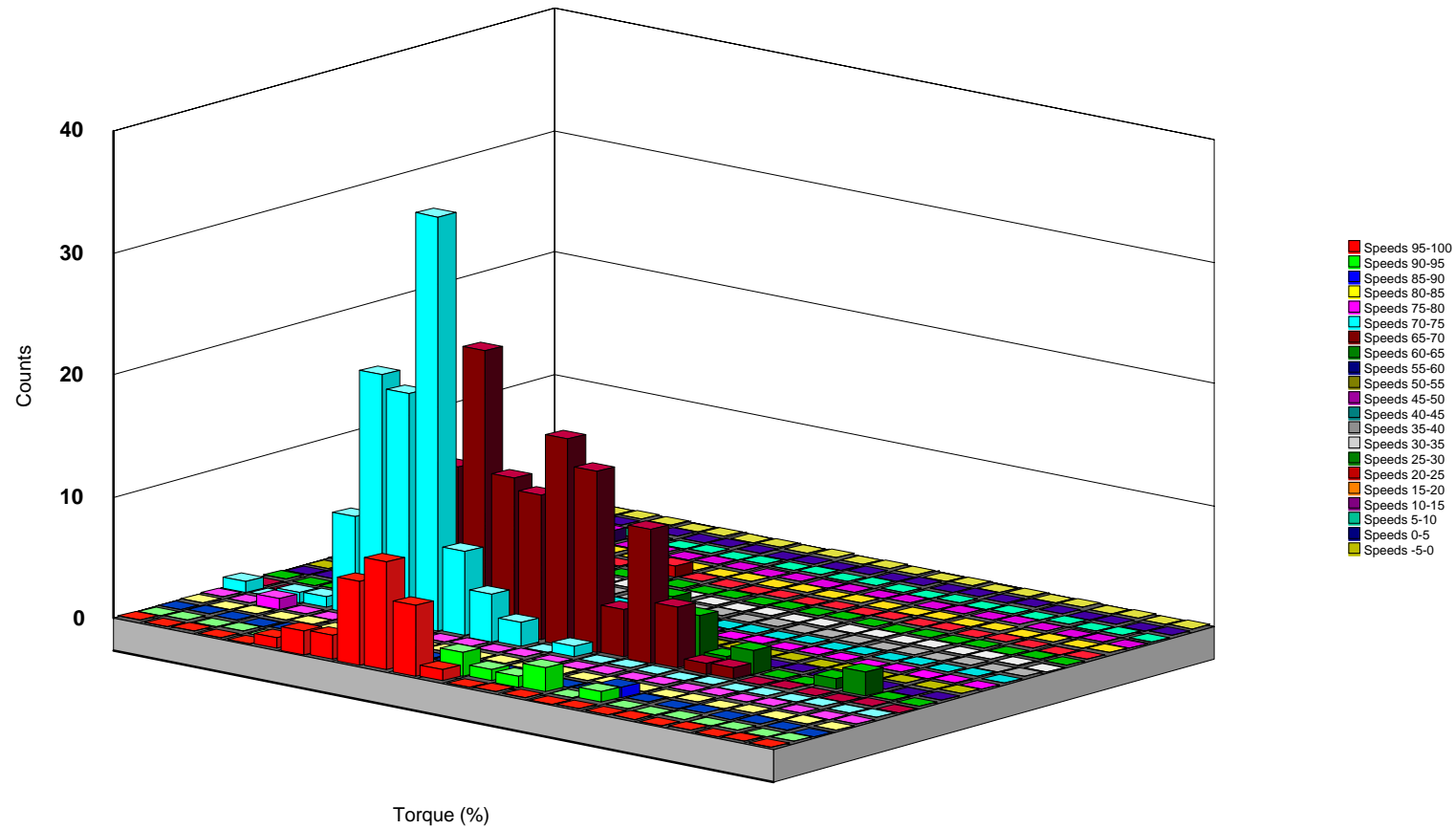


## SKID STEER LOADER HIGH TORQUE TRANSIENT--Mean Torque Changes

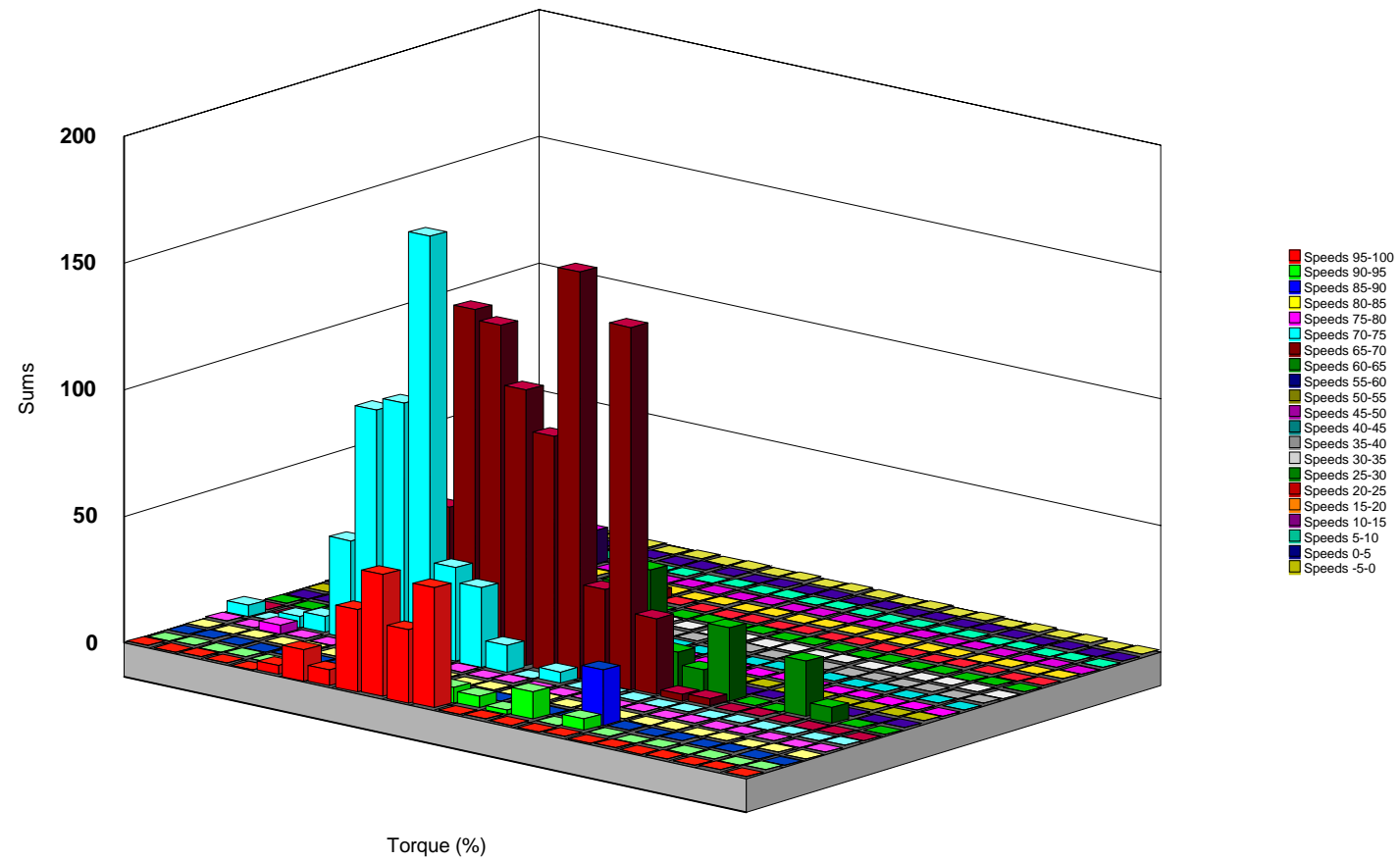




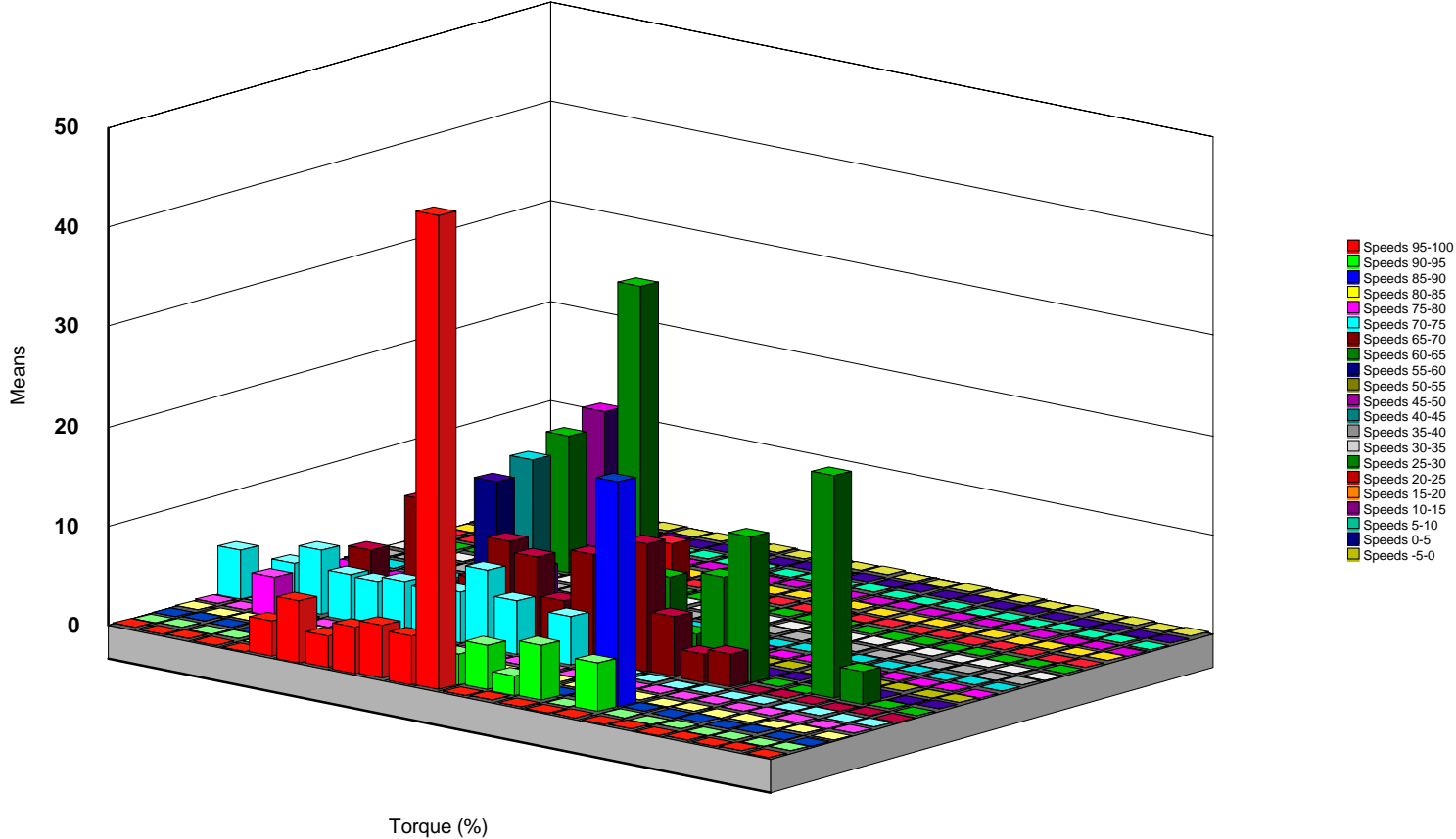
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Counts



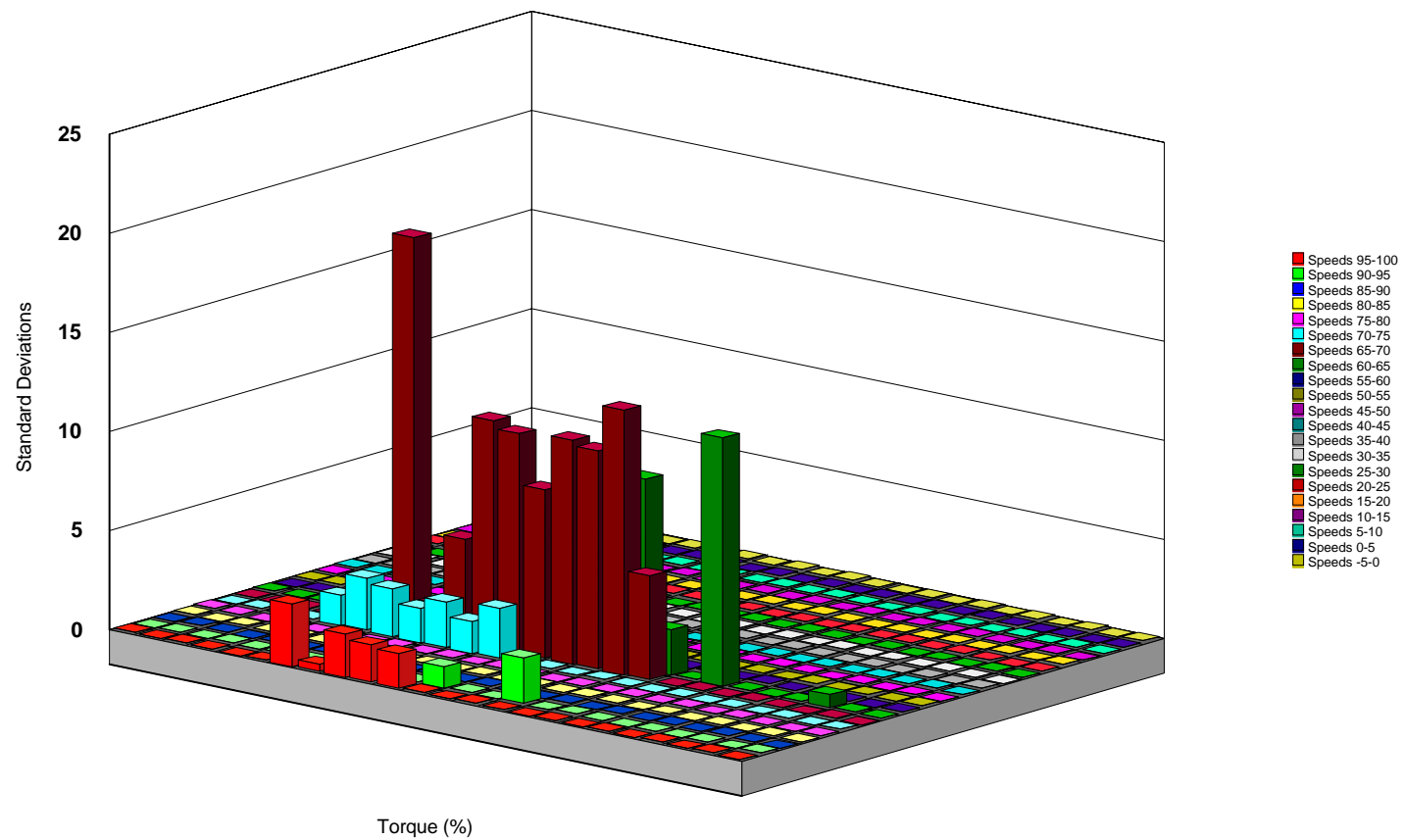
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Sums

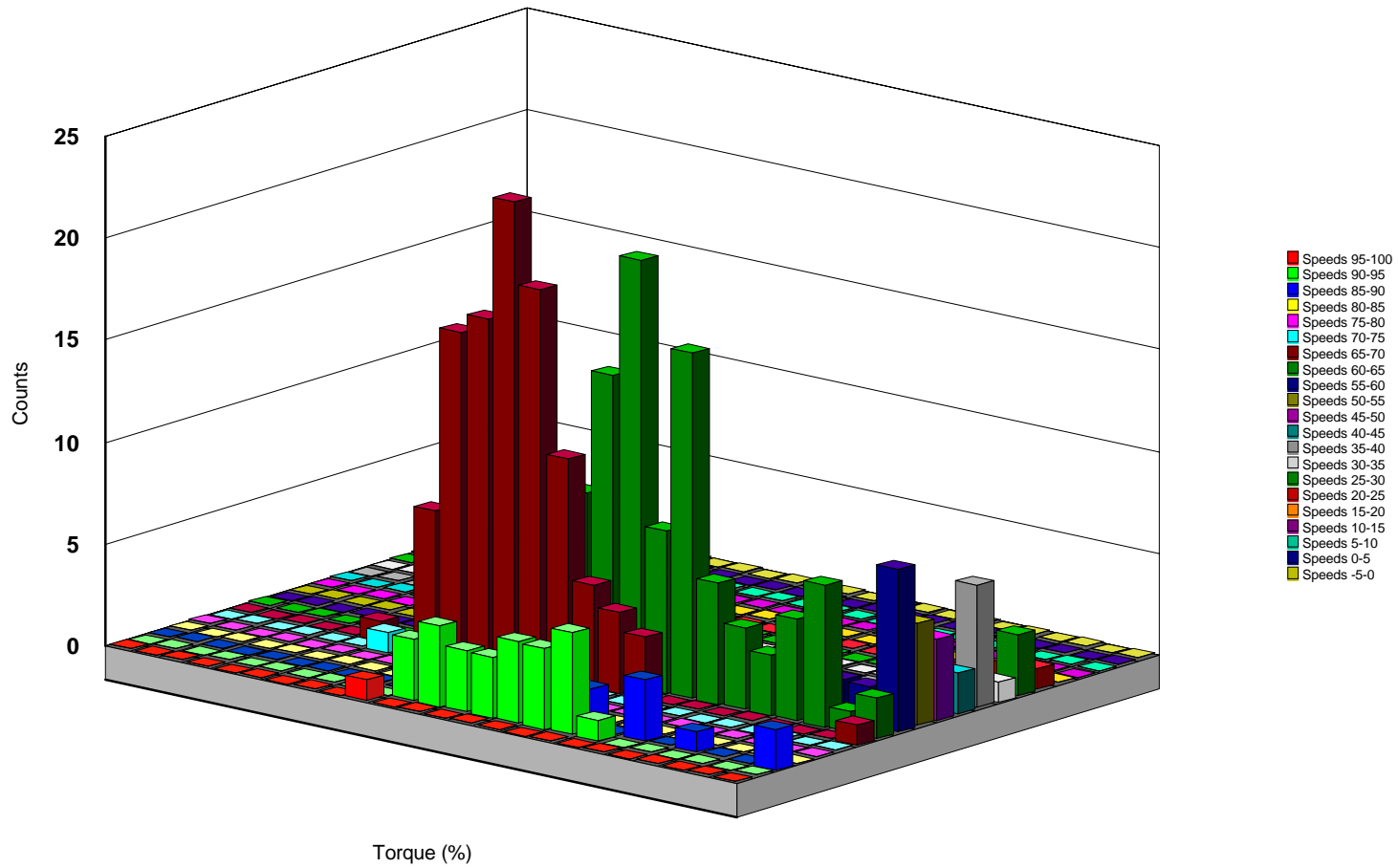


SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Means

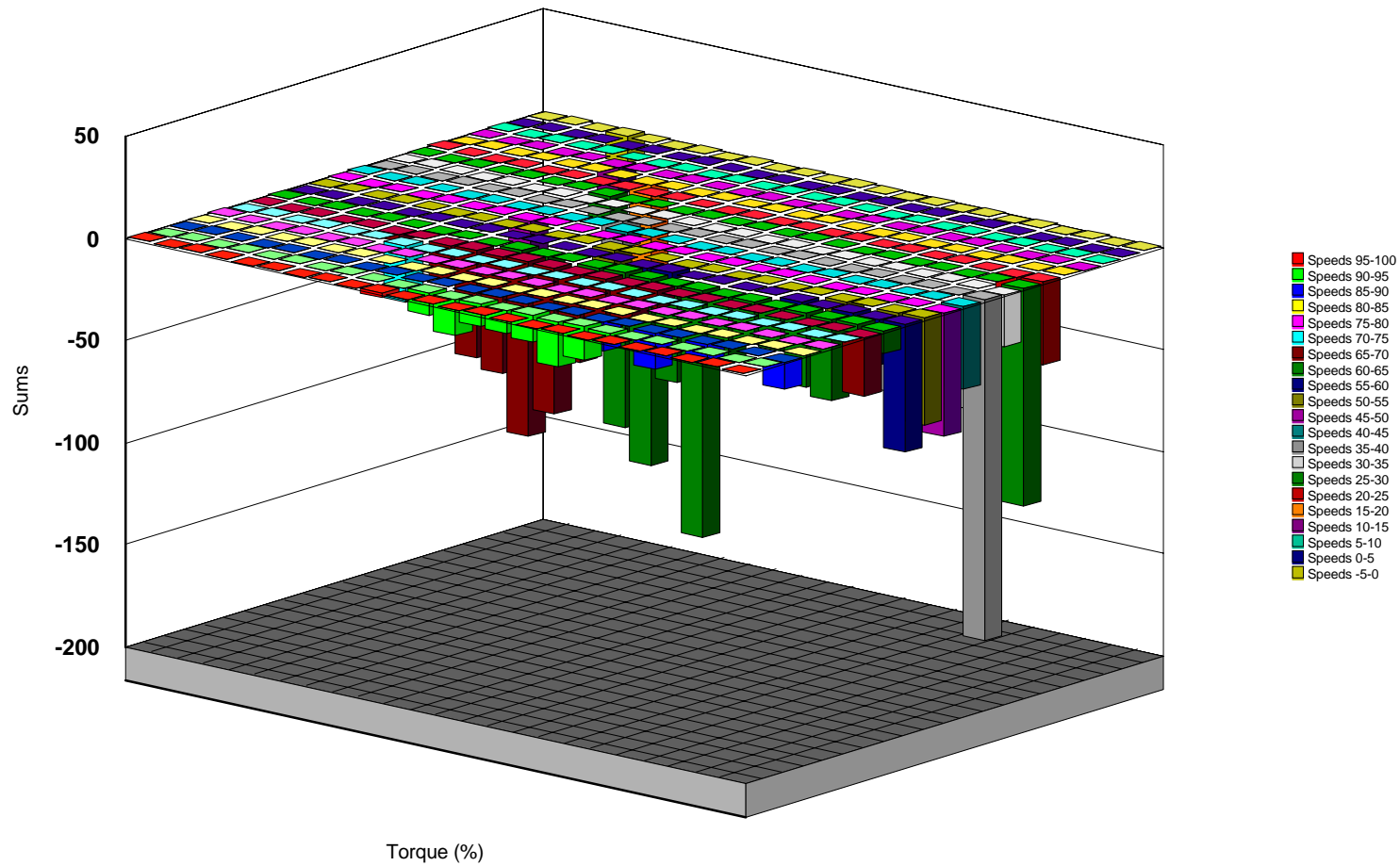


# SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Acceleration Standard Deviations

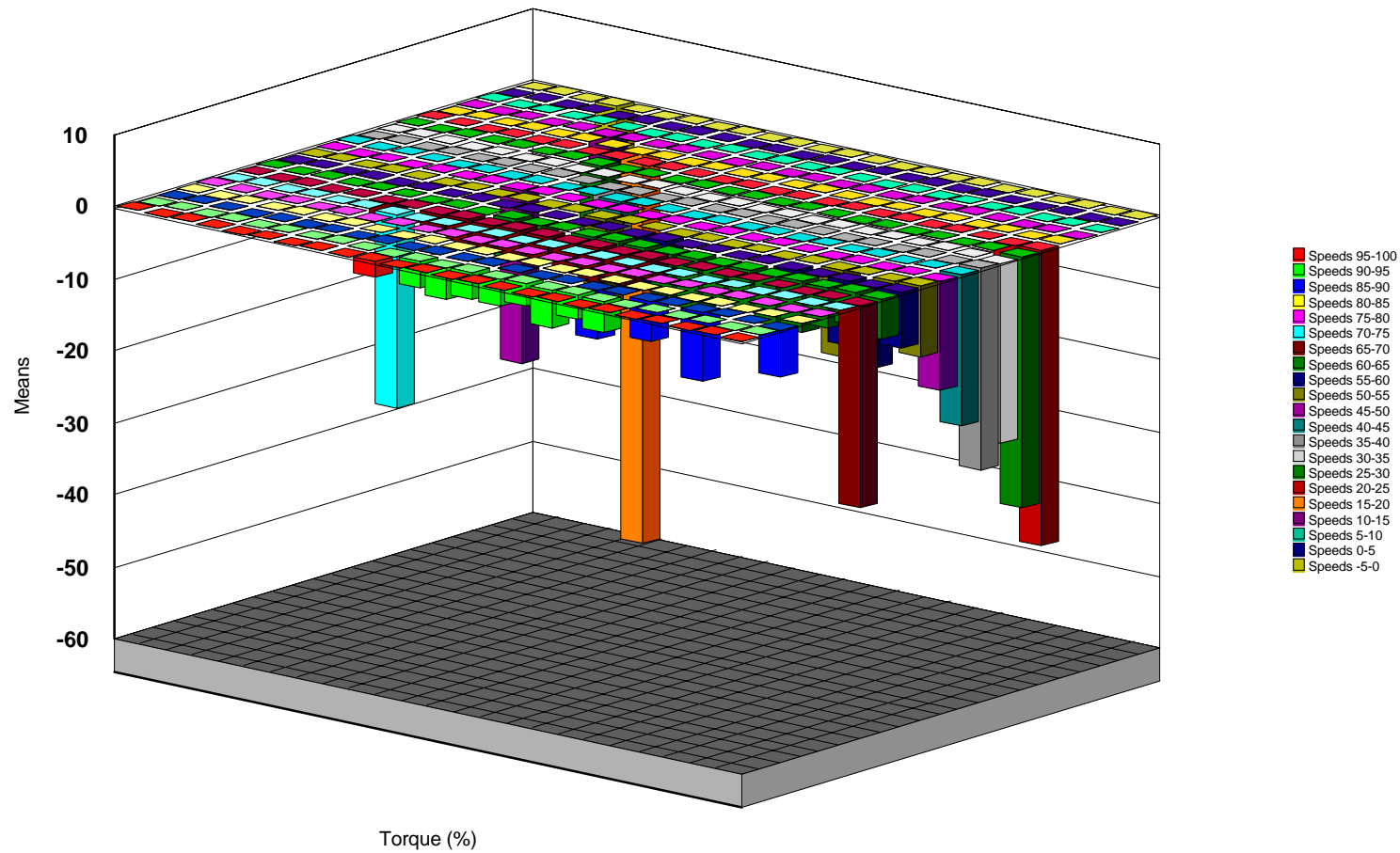


[illegible]

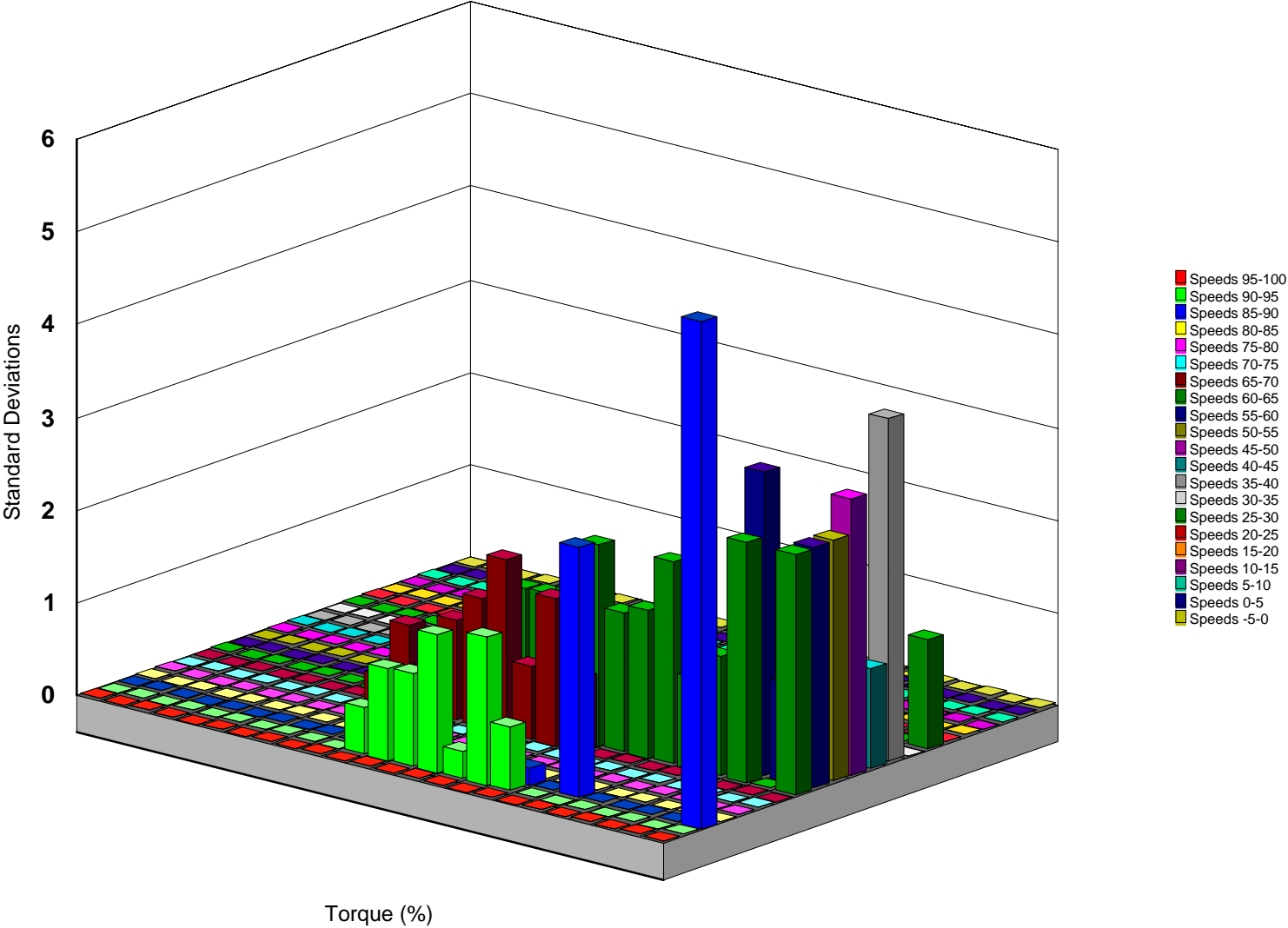
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Sums



## SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Means

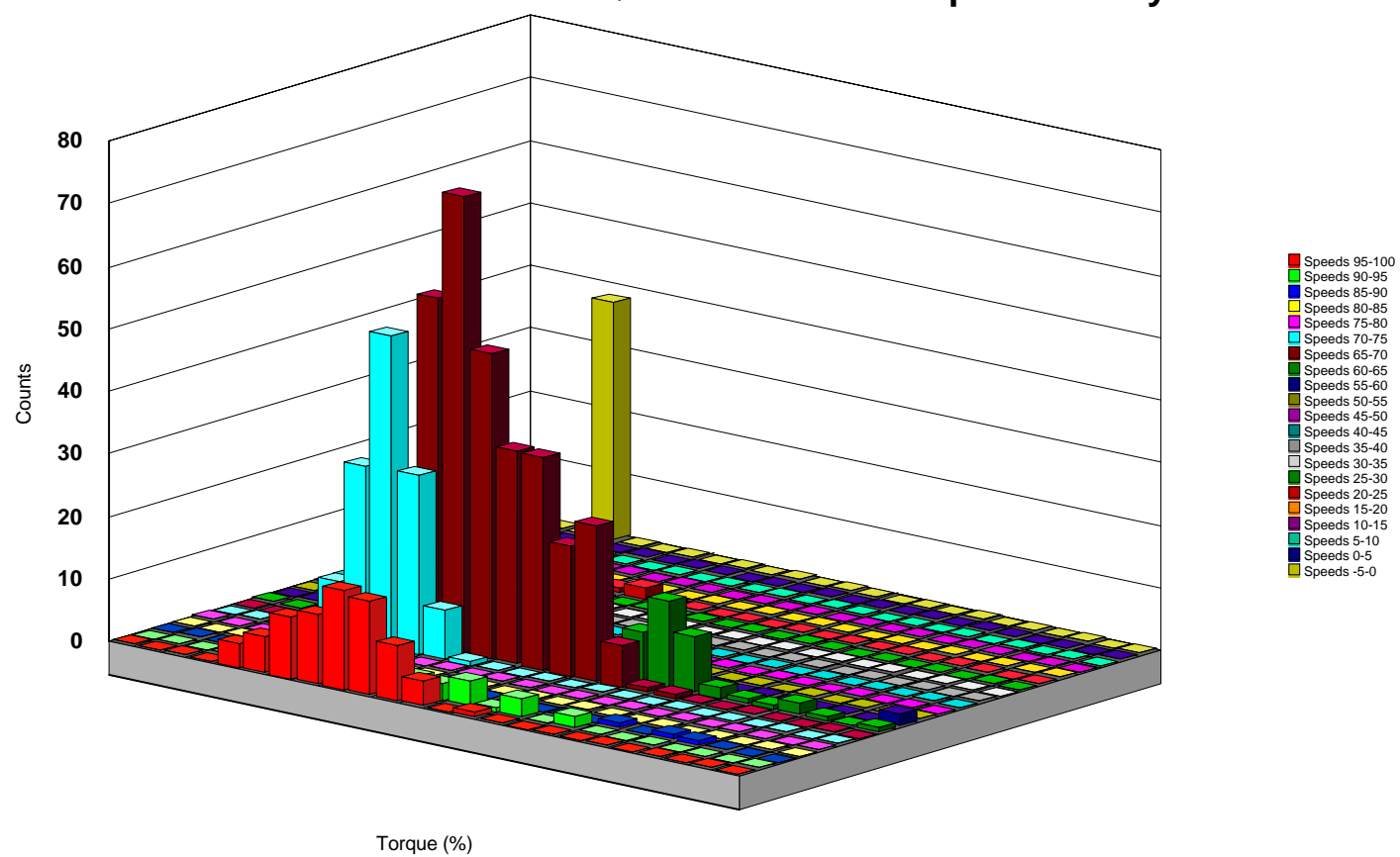


SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Deceleration Standard Deviations

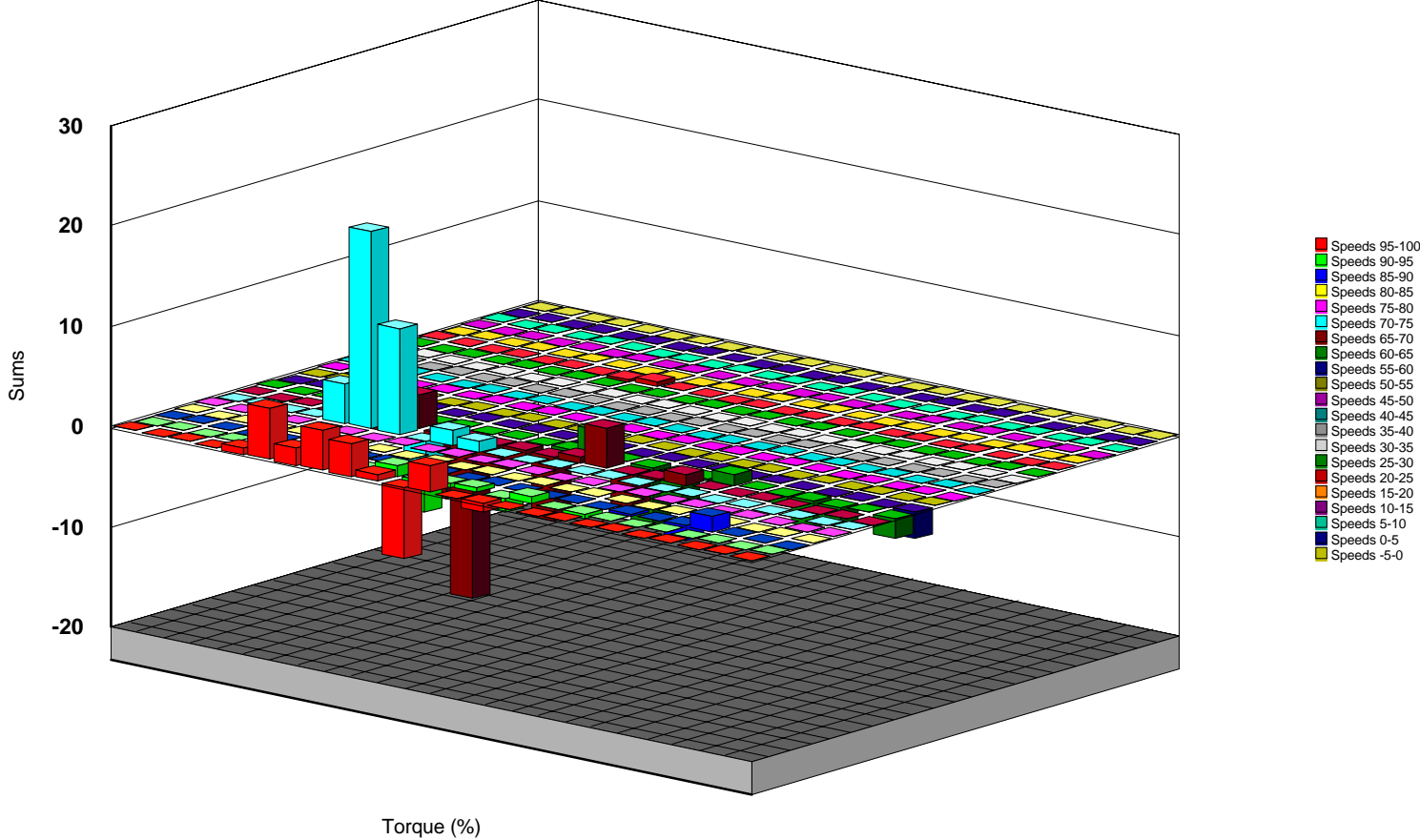




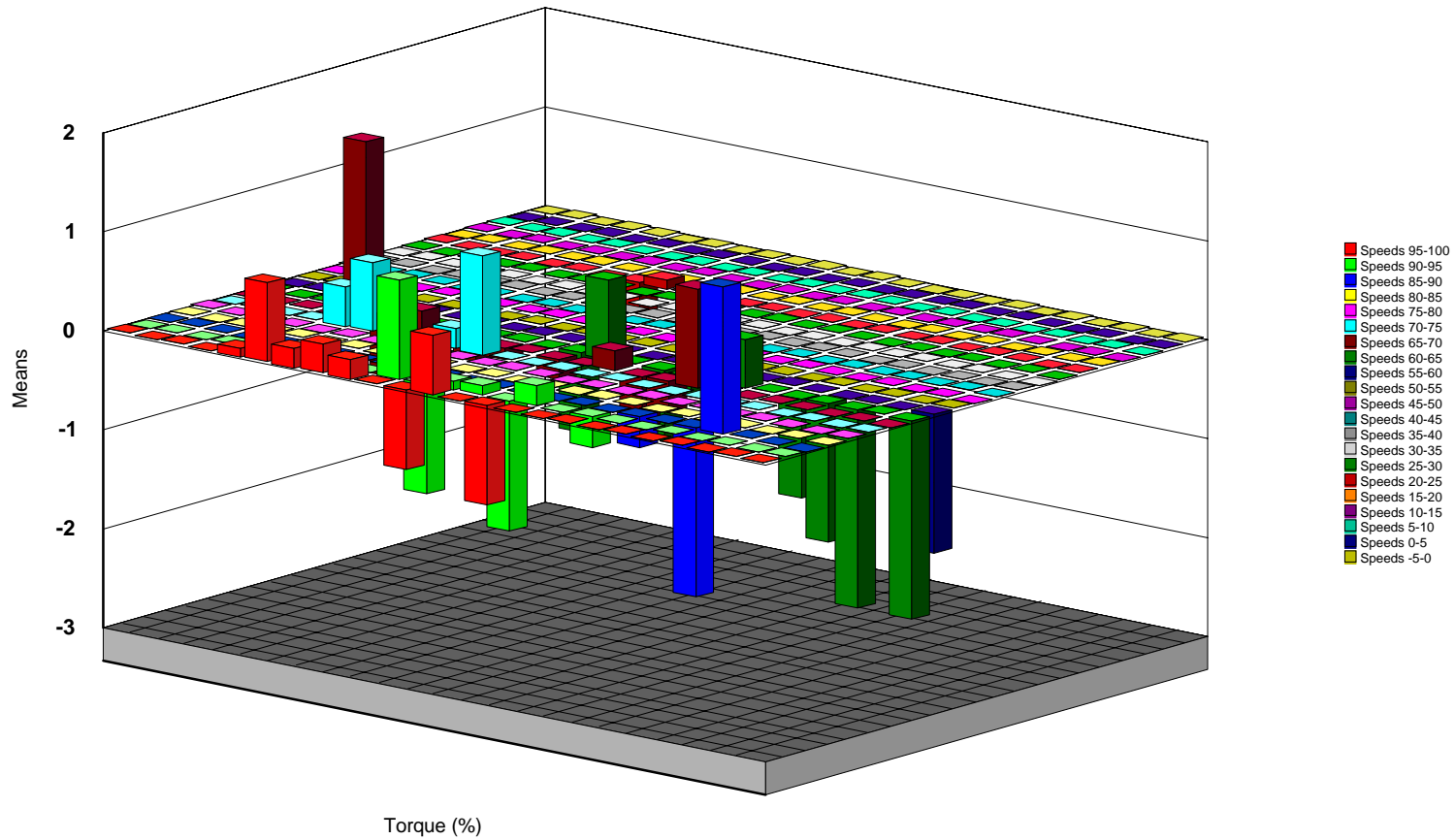
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Steady State Counts



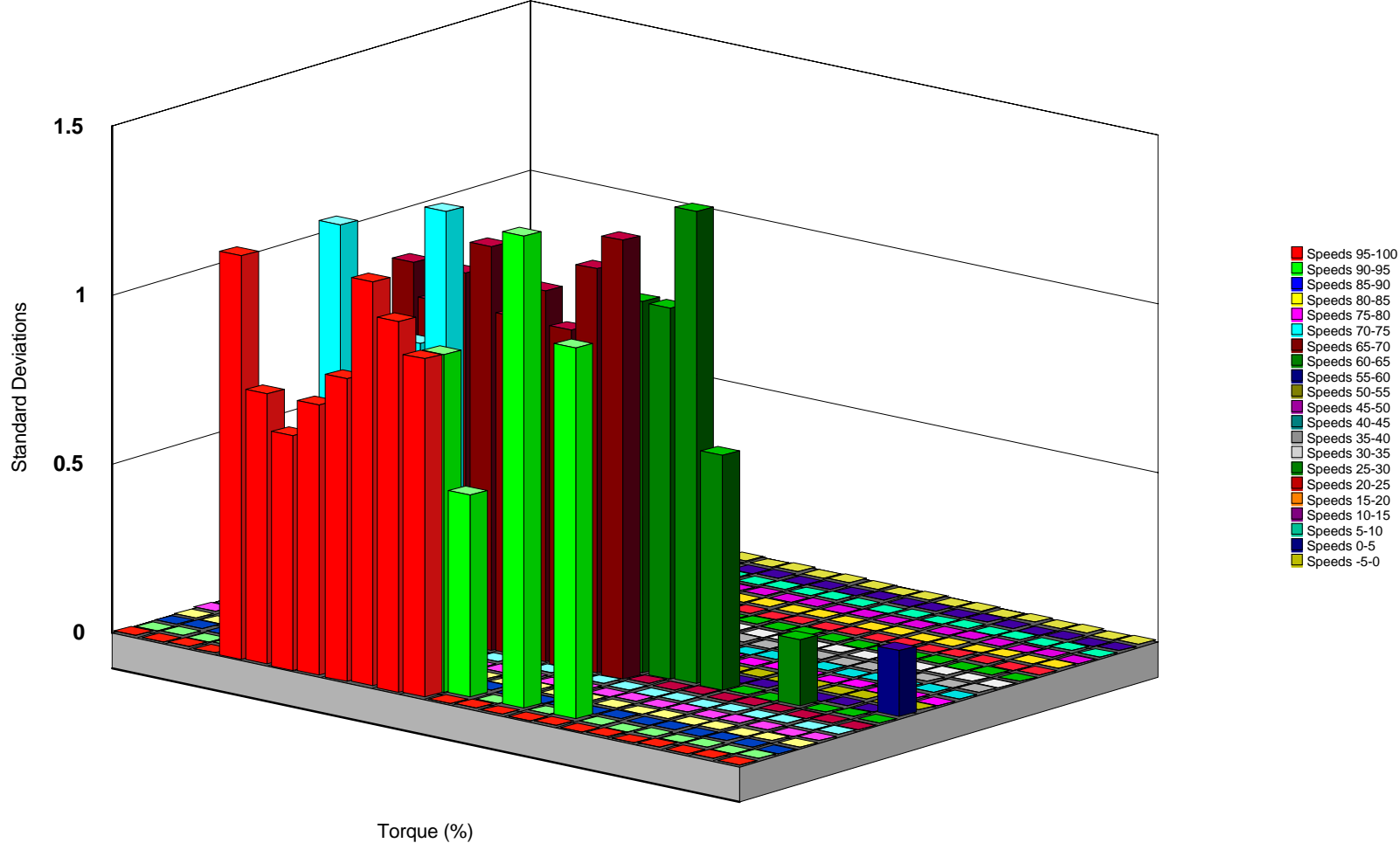
SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Steady State Sums



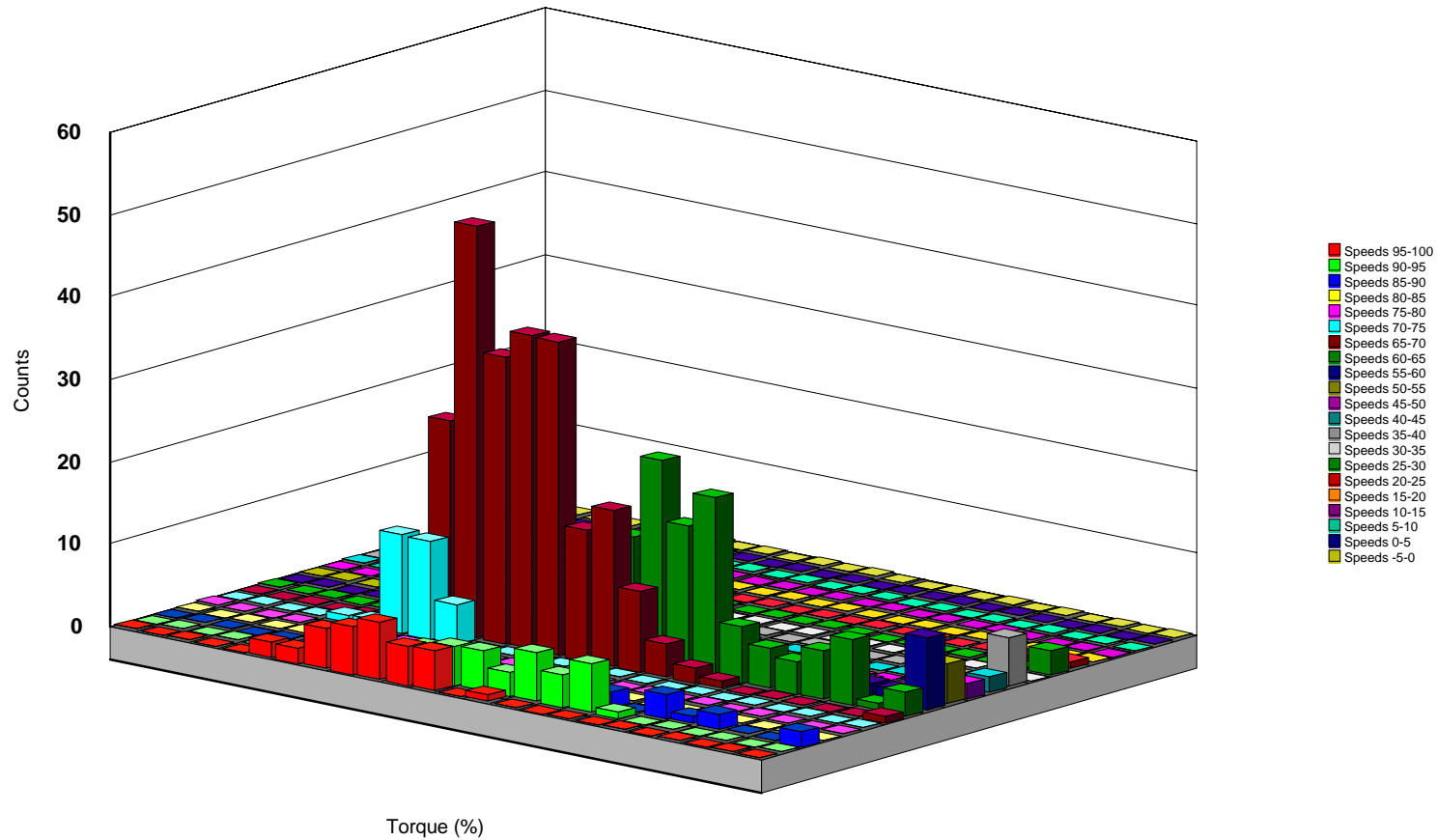
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Steady State Means



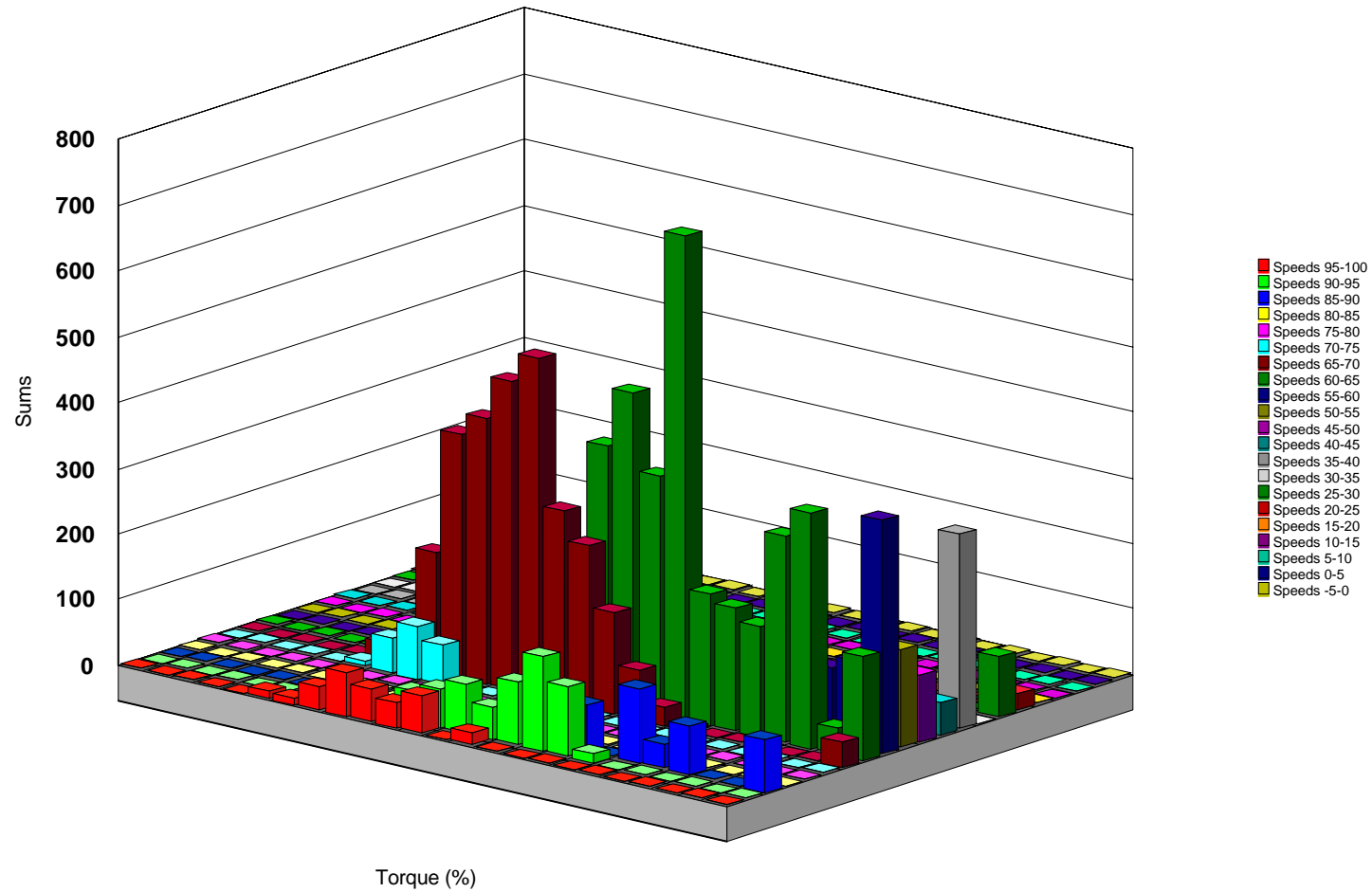
SKID STEER LOADER HIGH TORQUE TRANSIENT--Speed Steady State Standard Deviations



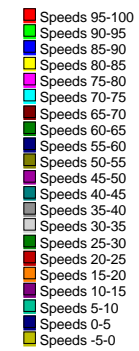
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Acceleration Counts



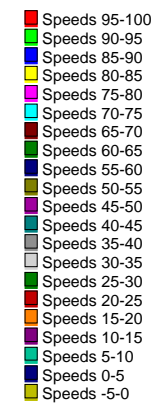
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Acceleration Sum



A 3D bar chart illustrating the relationship between Torque (%) and Mean values. The vertical axis (Y-axis) is labeled 'Means' and ranges from 0 to 80. The horizontal axis (X-axis) is labeled 'Torque (%)' and ranges from 0 to 100. The depth axis (Z-axis) represents different conditions, color-coded by group: Red, Green, Blue, and Purple. The chart shows a general increase in Mean values as Torque increases, with the highest values reaching approximately 55 for the Blue group at 70% Torque.

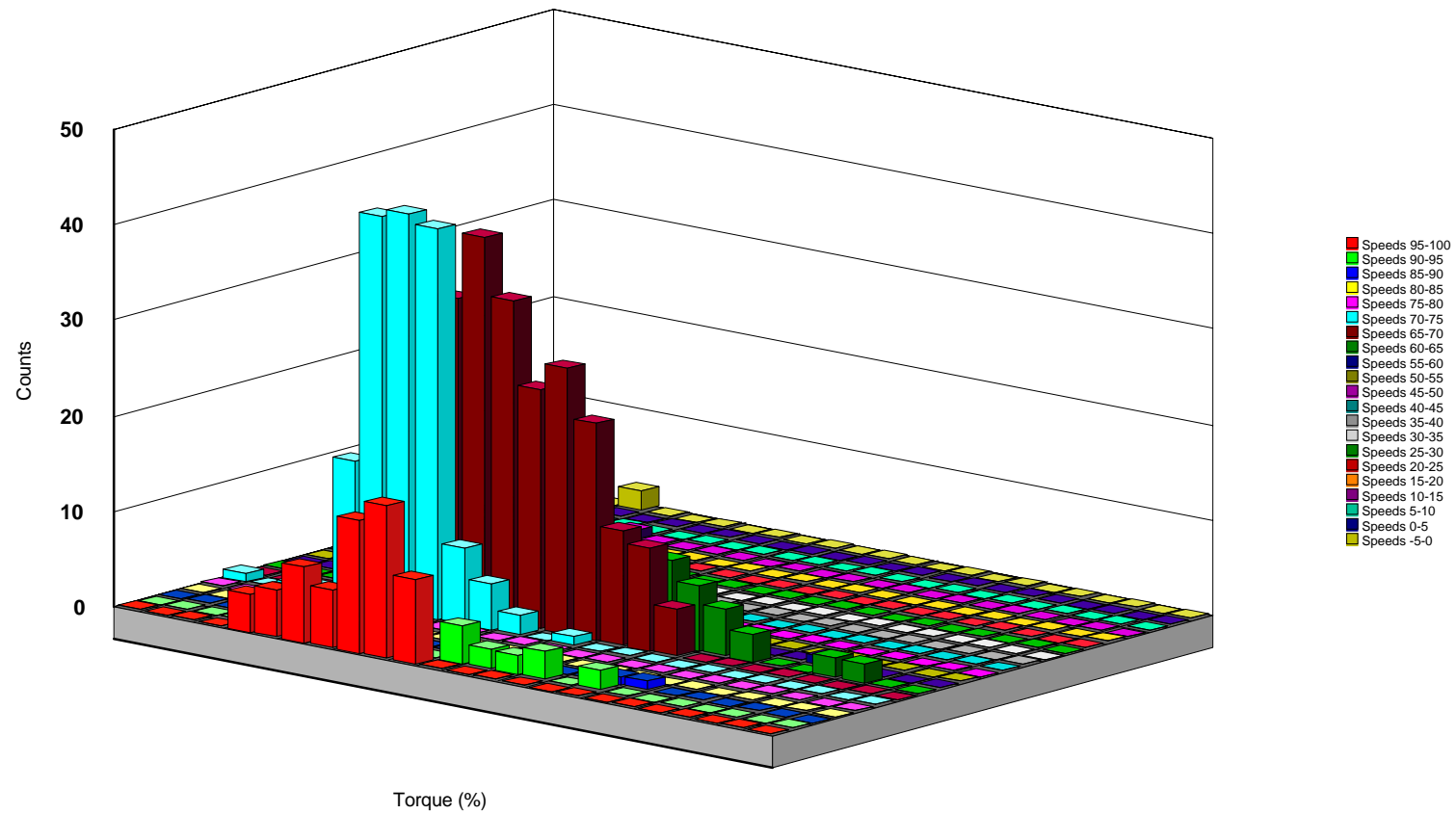


A 3D bar chart illustrating the Standard Deviations (Y-axis, ranging from 0 to 40) across different Torque (%) values (X-axis, ranging from 0 to 100). The Z-axis represents various conditions, color-coded as follows: Red (0-20%), Green (20-40%), Blue (40-60%), Dark Blue (60-80%), Yellow (80-100%), and Grey (100-120%). The chart shows that Standard Deviations generally increase with Torque, with the highest values (around 25) observed at 60% Torque for the Blue condition.

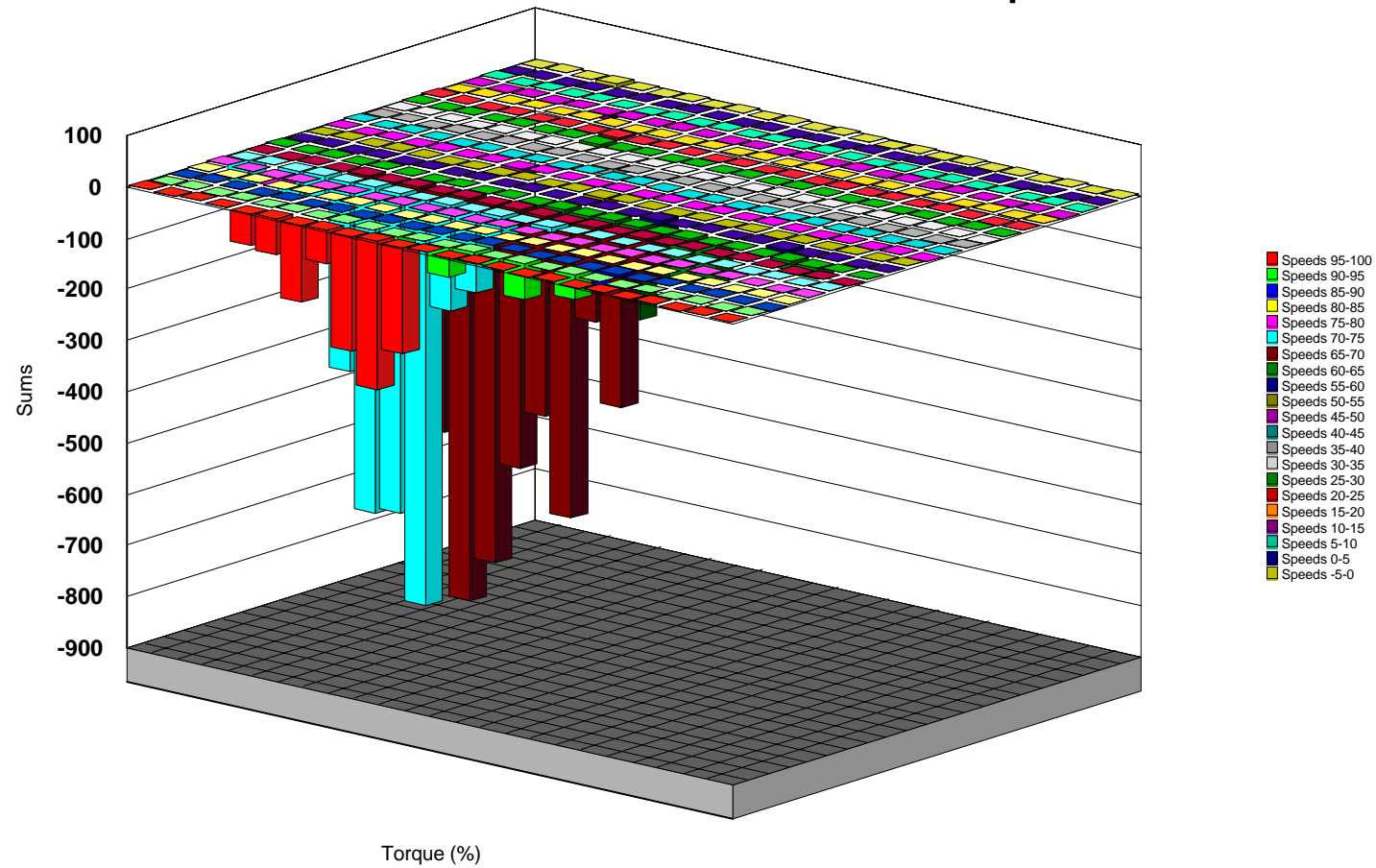




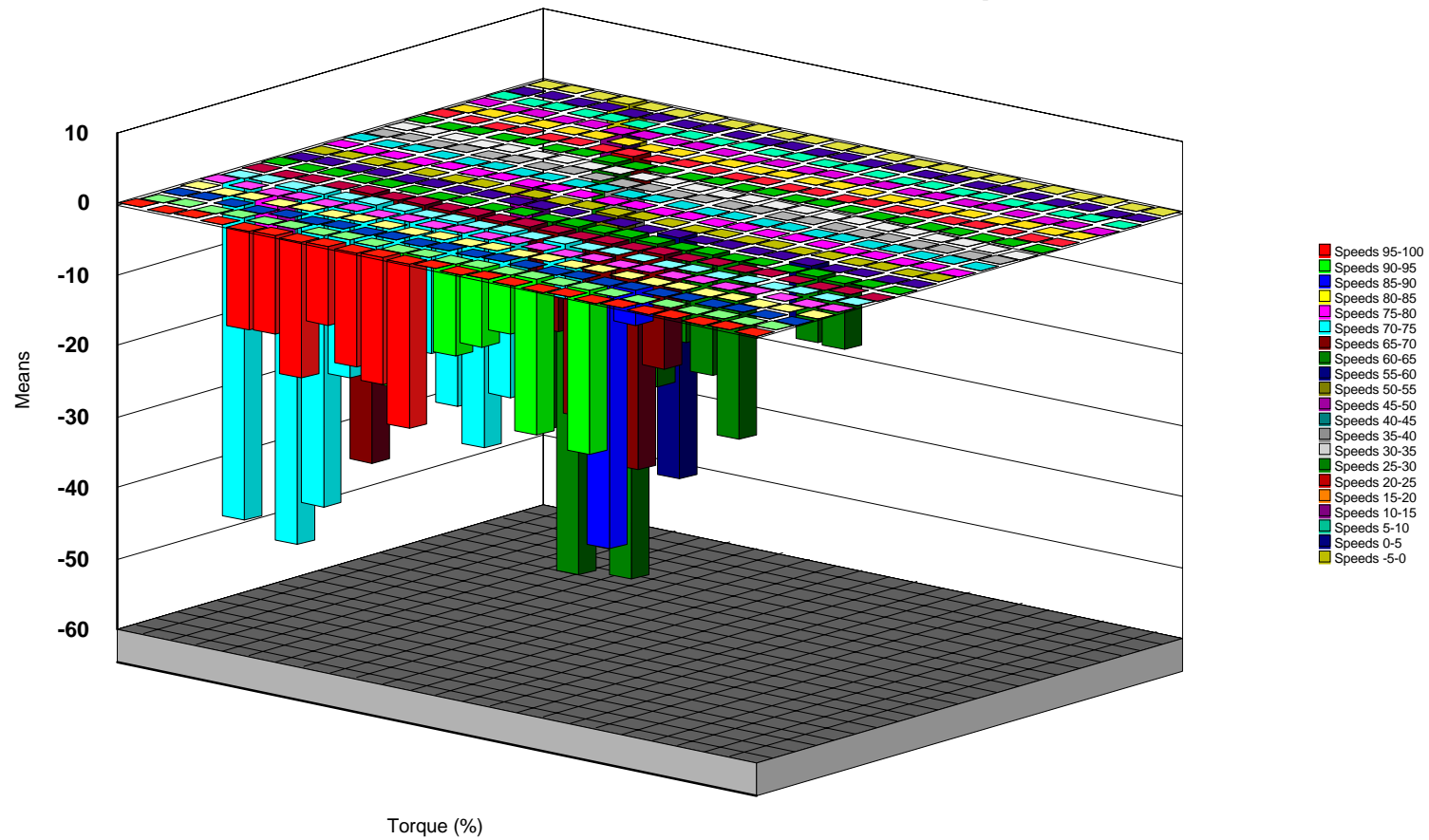
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Deceleration Counts



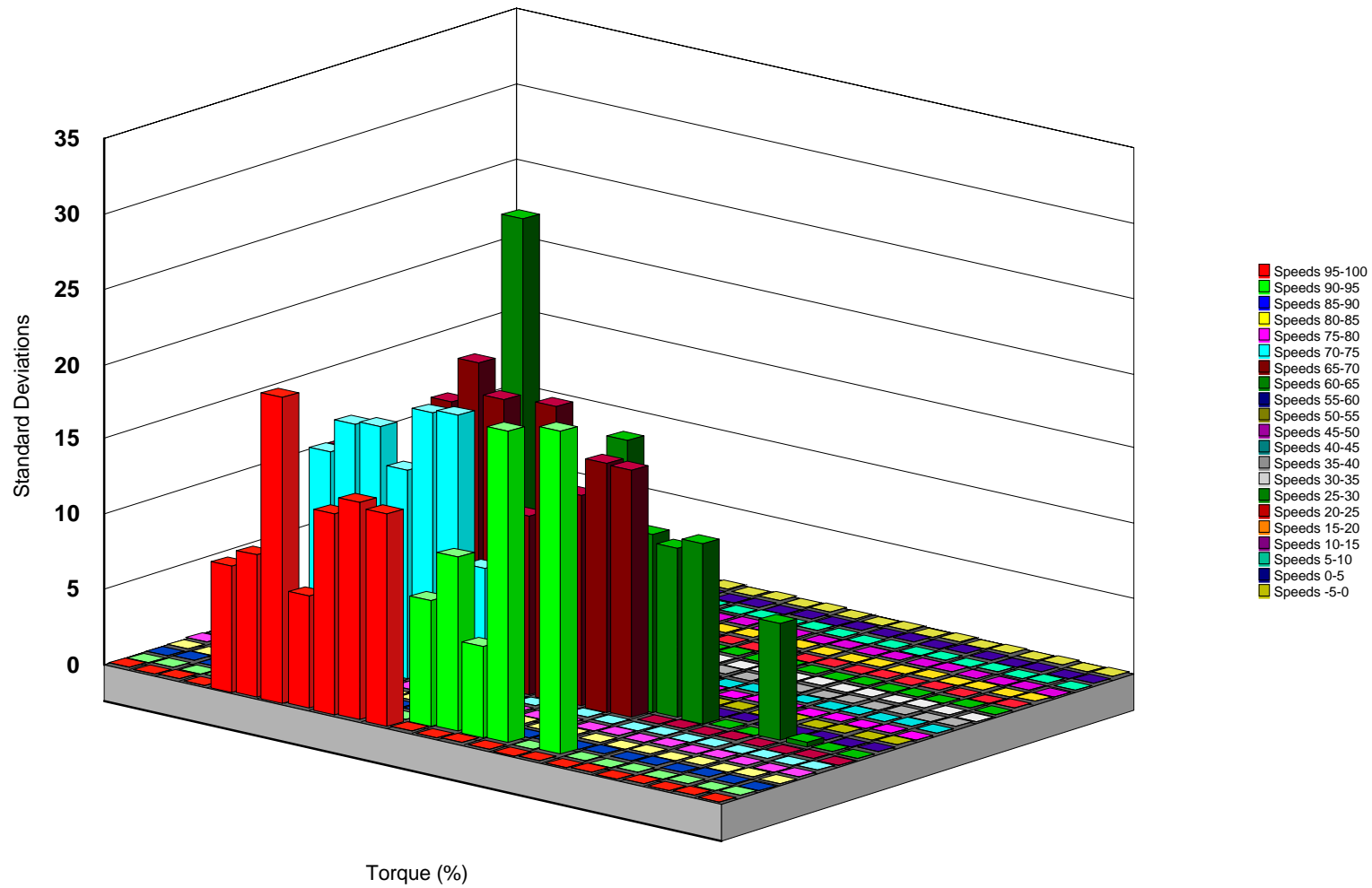
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Deceleration Sums



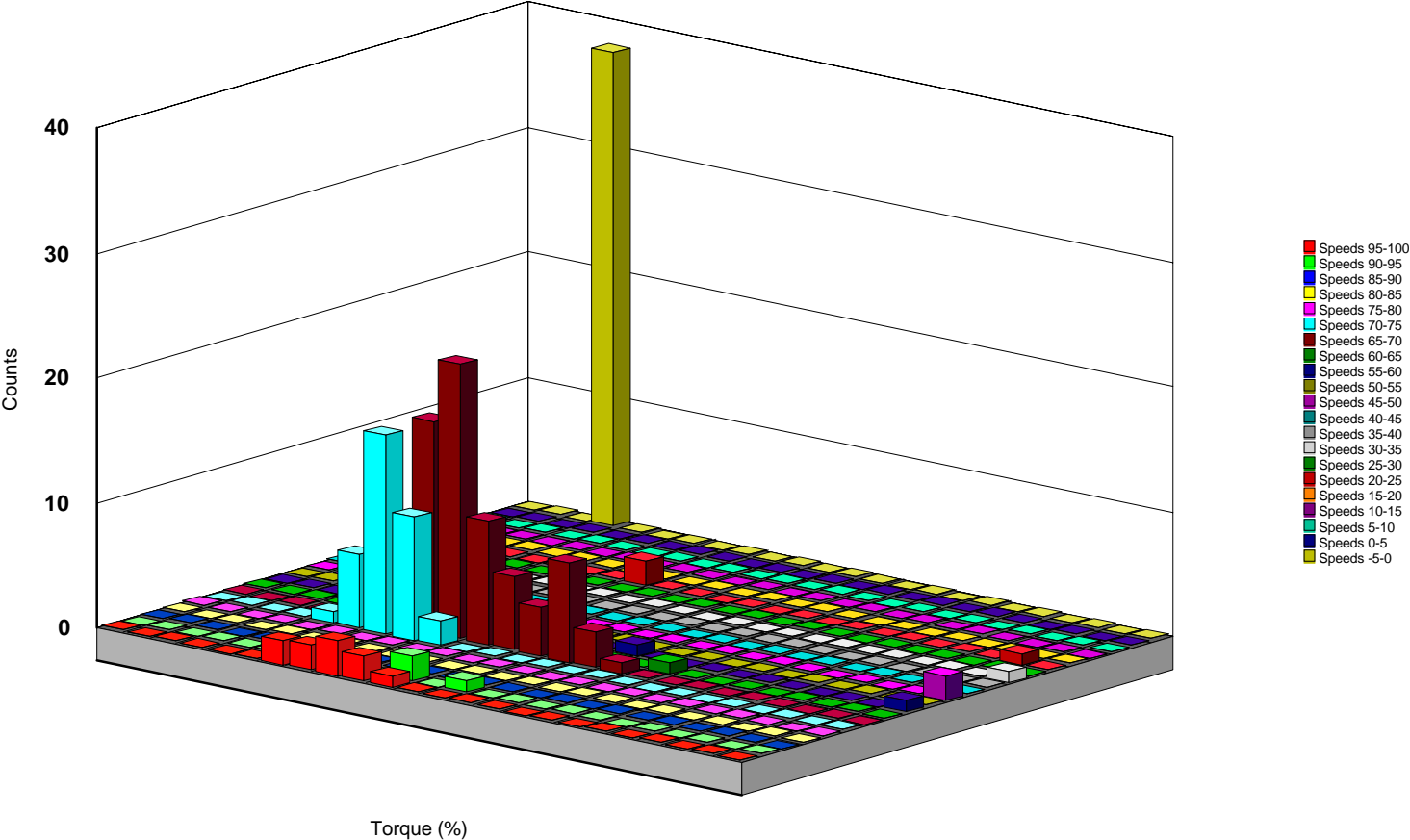
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Deceleration Means



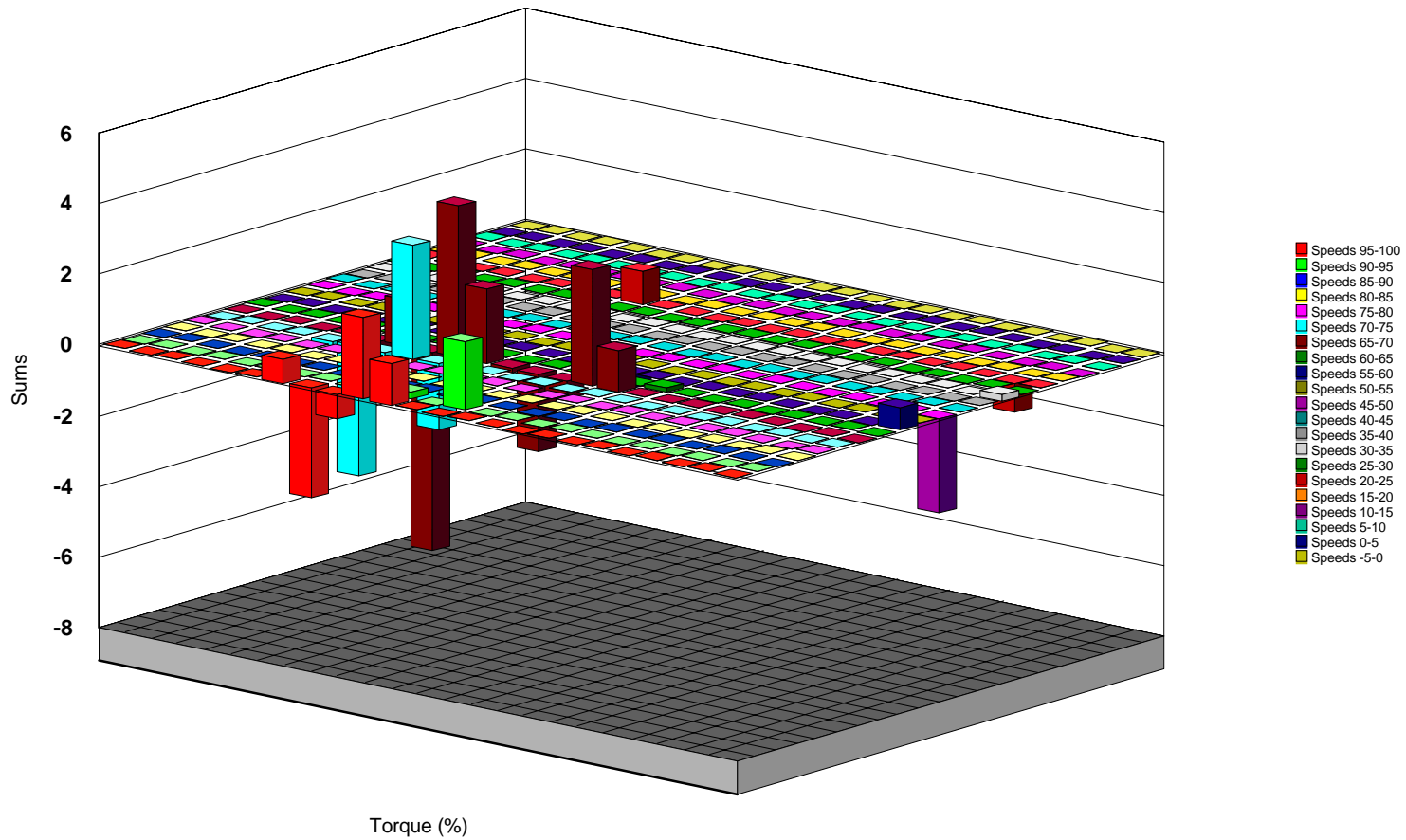
# SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Deceleration Standard Deviations



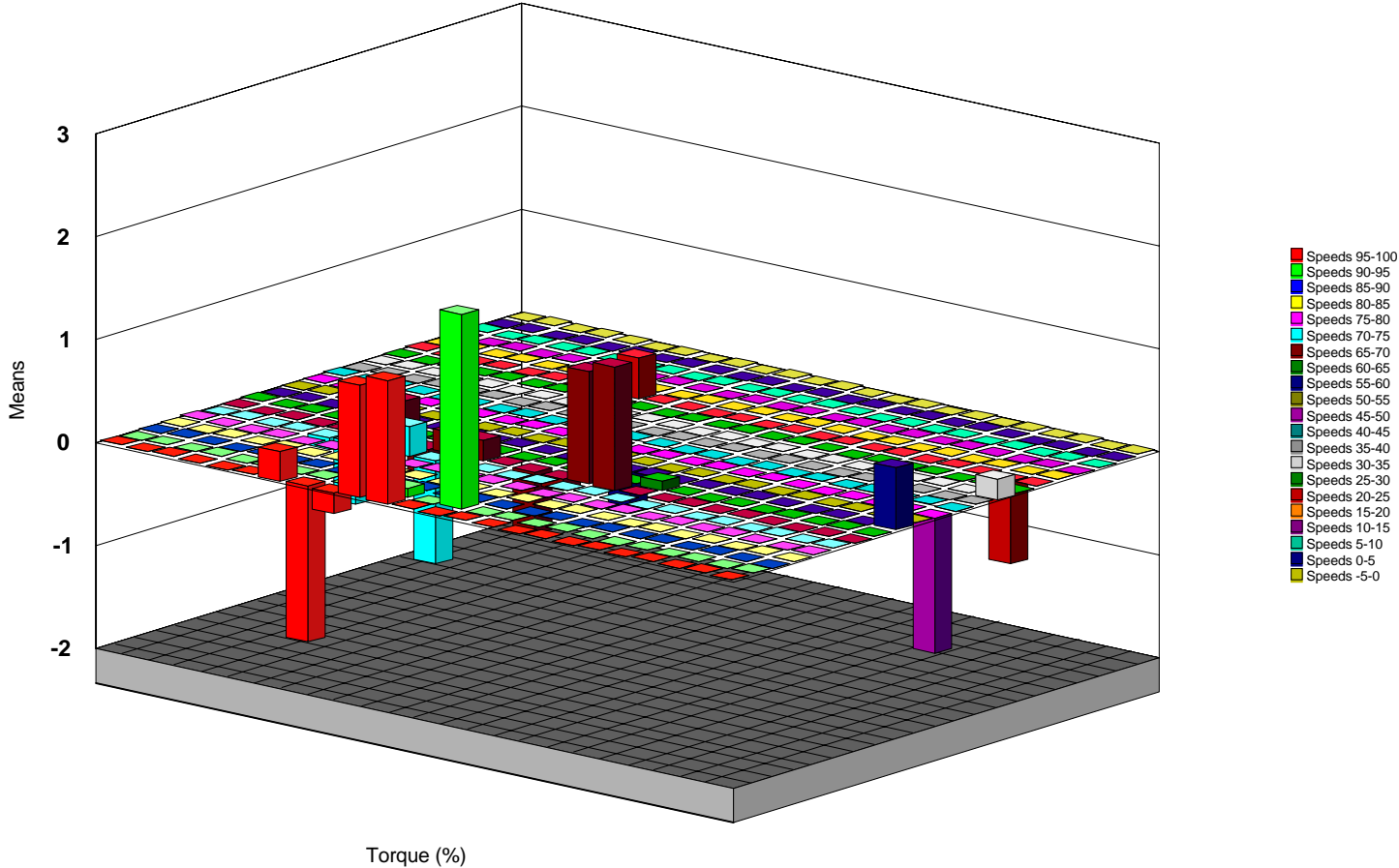
SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Steady State Counts



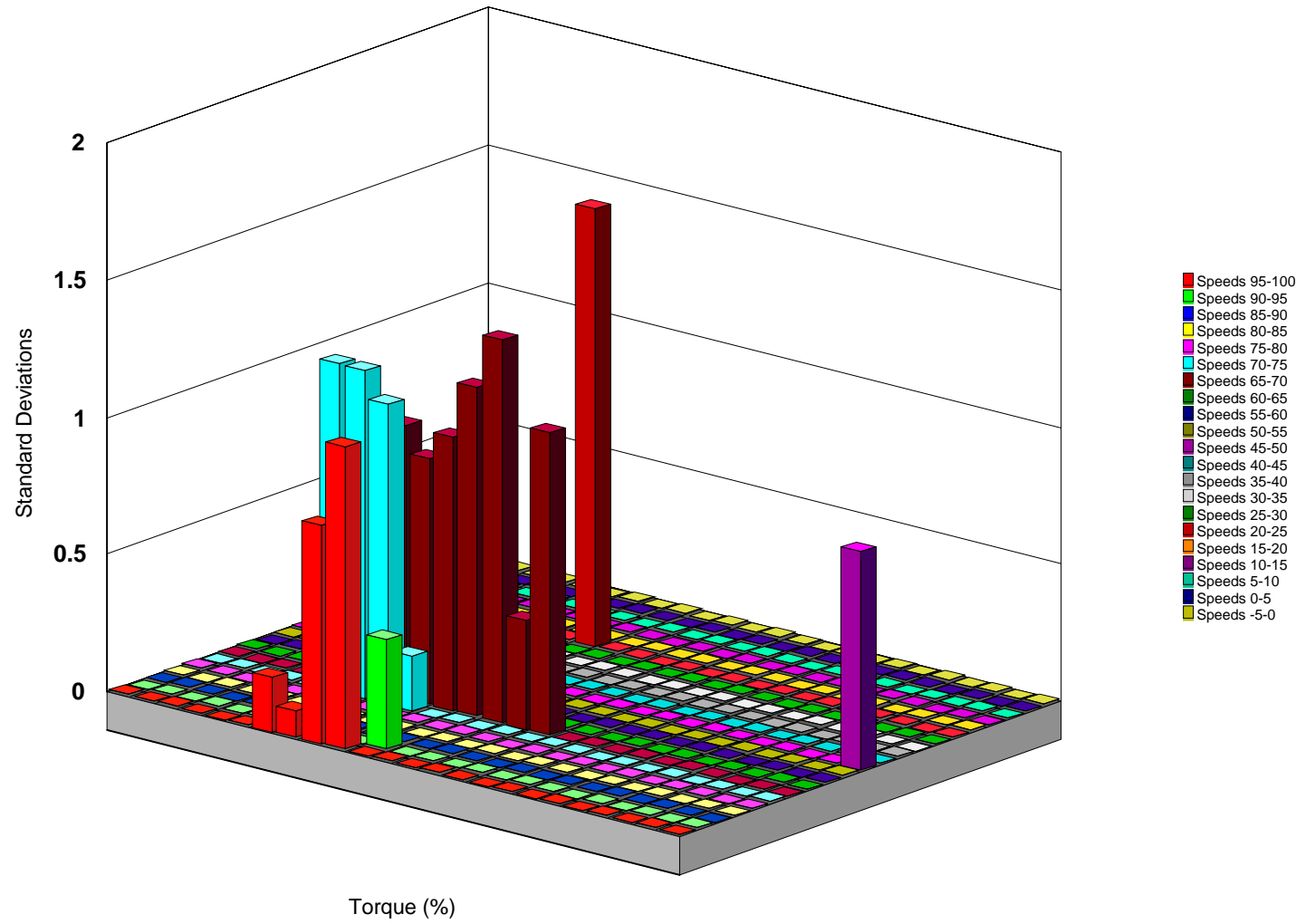
## SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Steady State Sums



SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Steady State Means

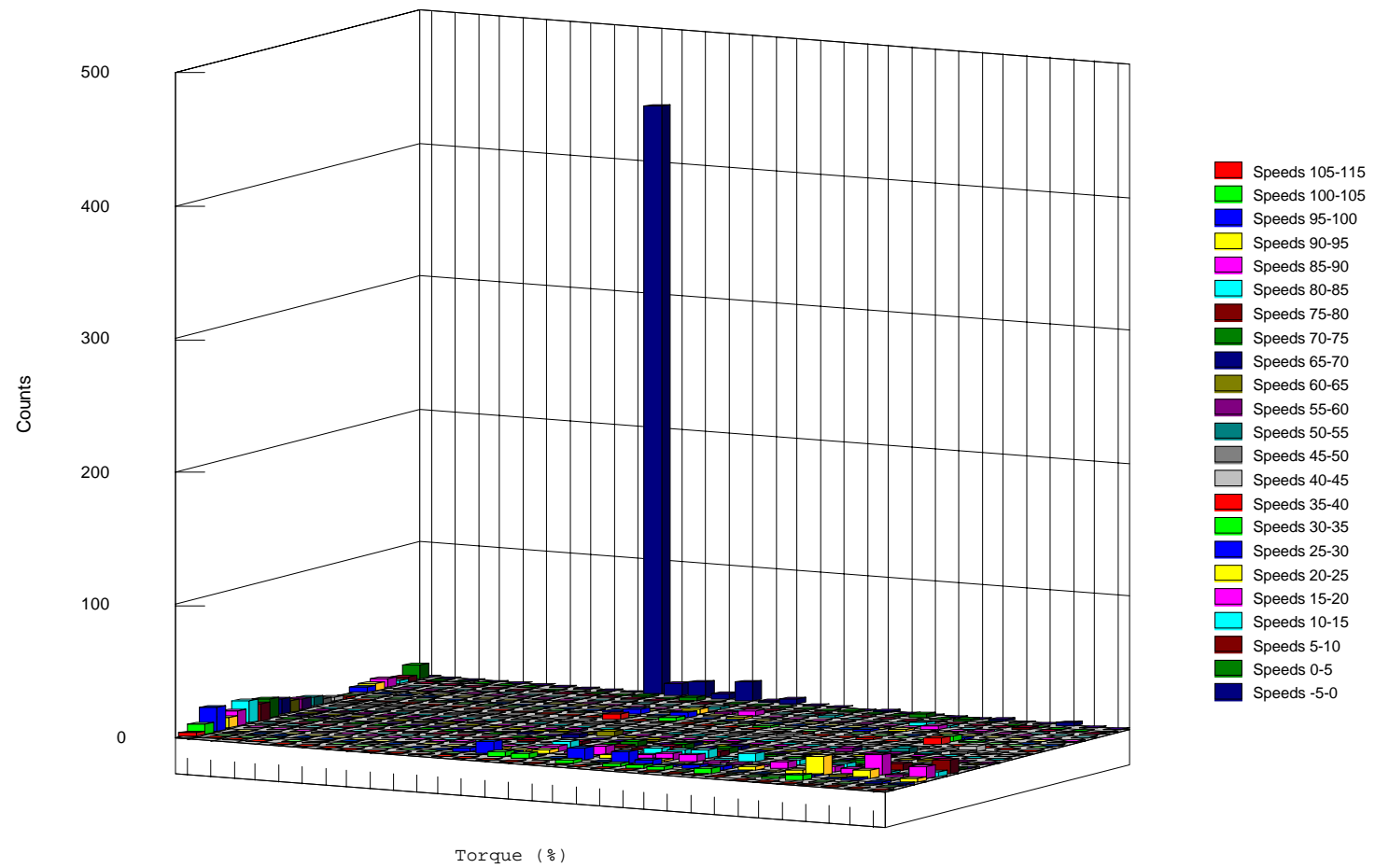


# SKID STEER LOADER HIGH TORQUE TRANSIENT--Torque Steady State Standard Deviations

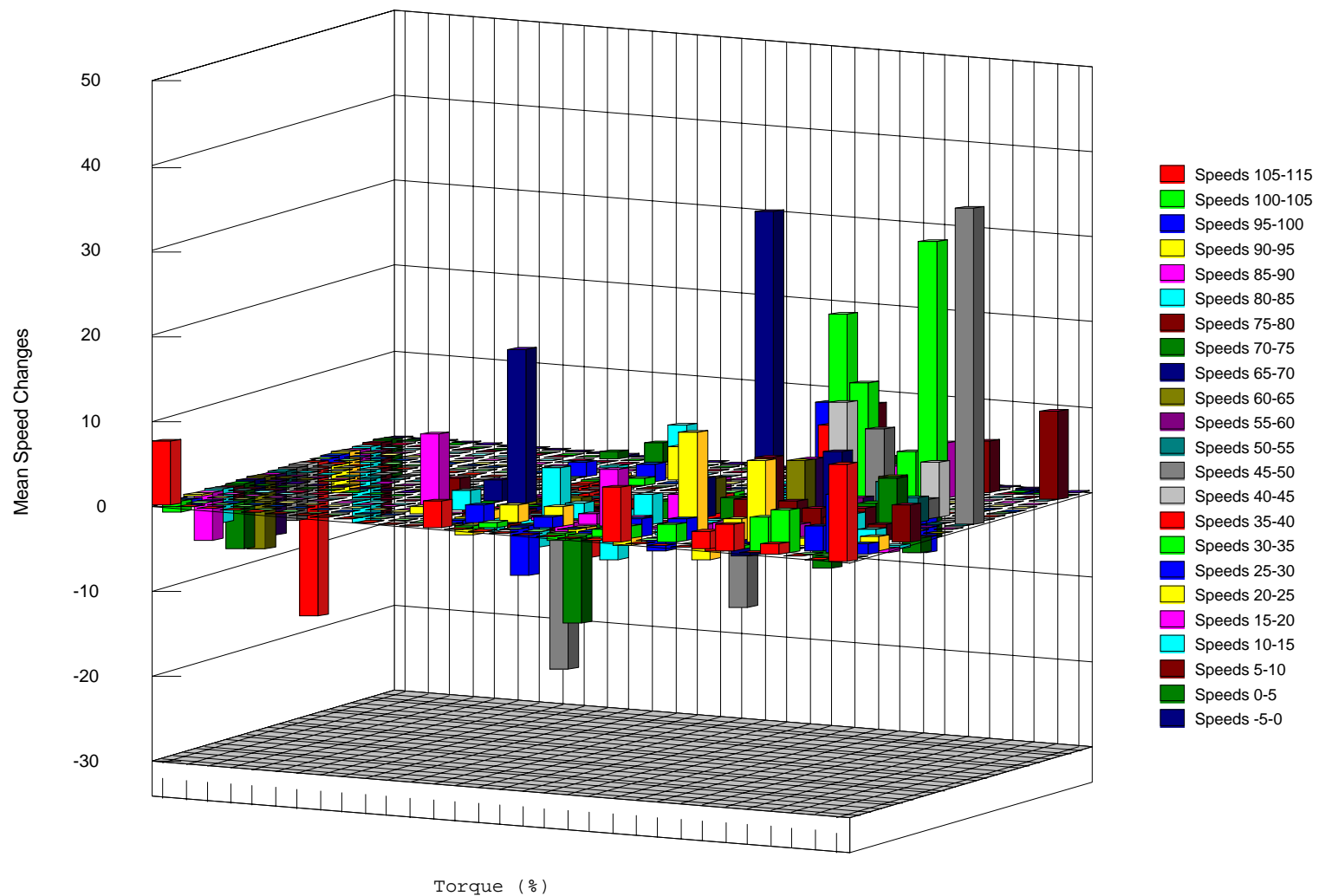




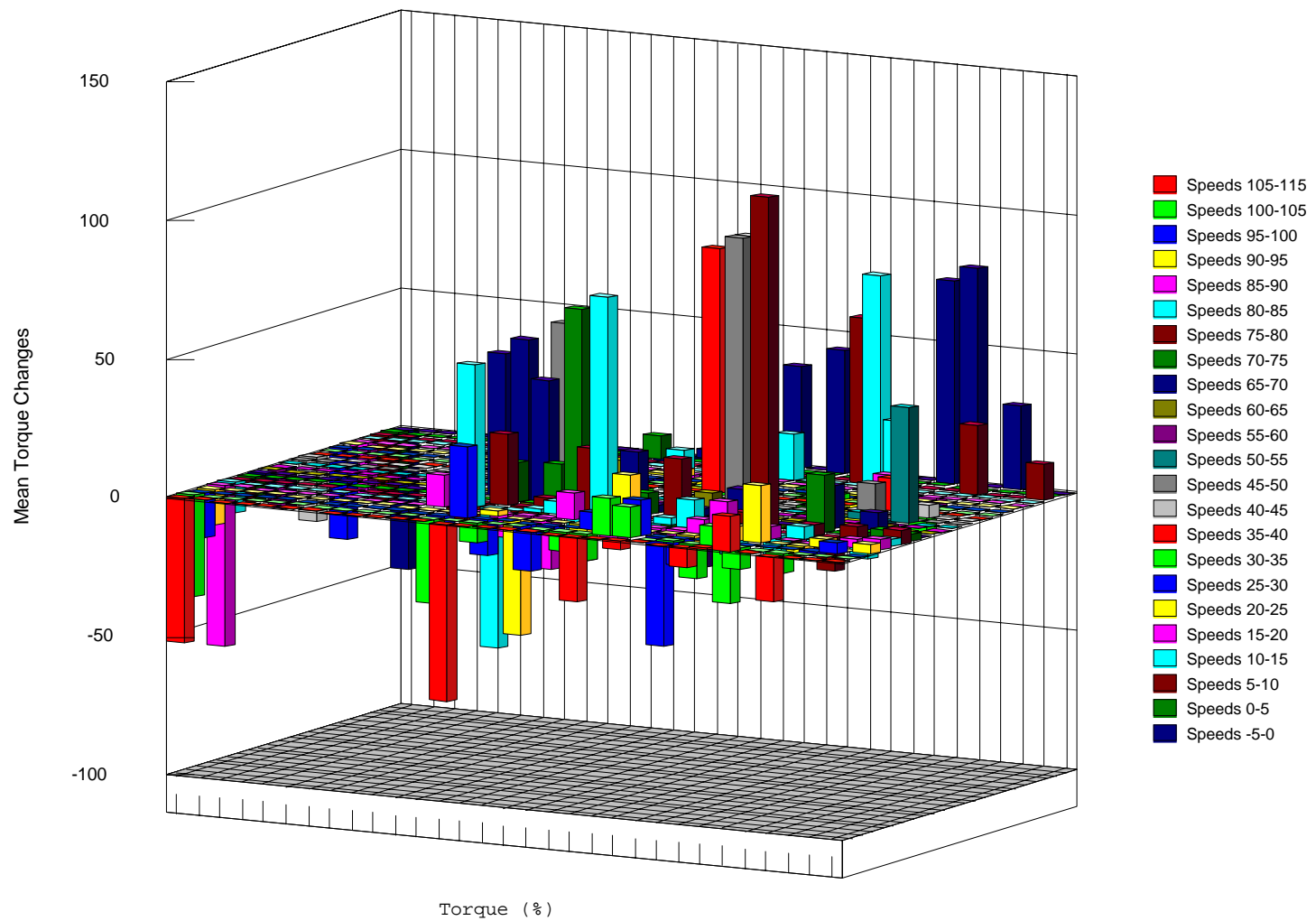
## FTP--Counts



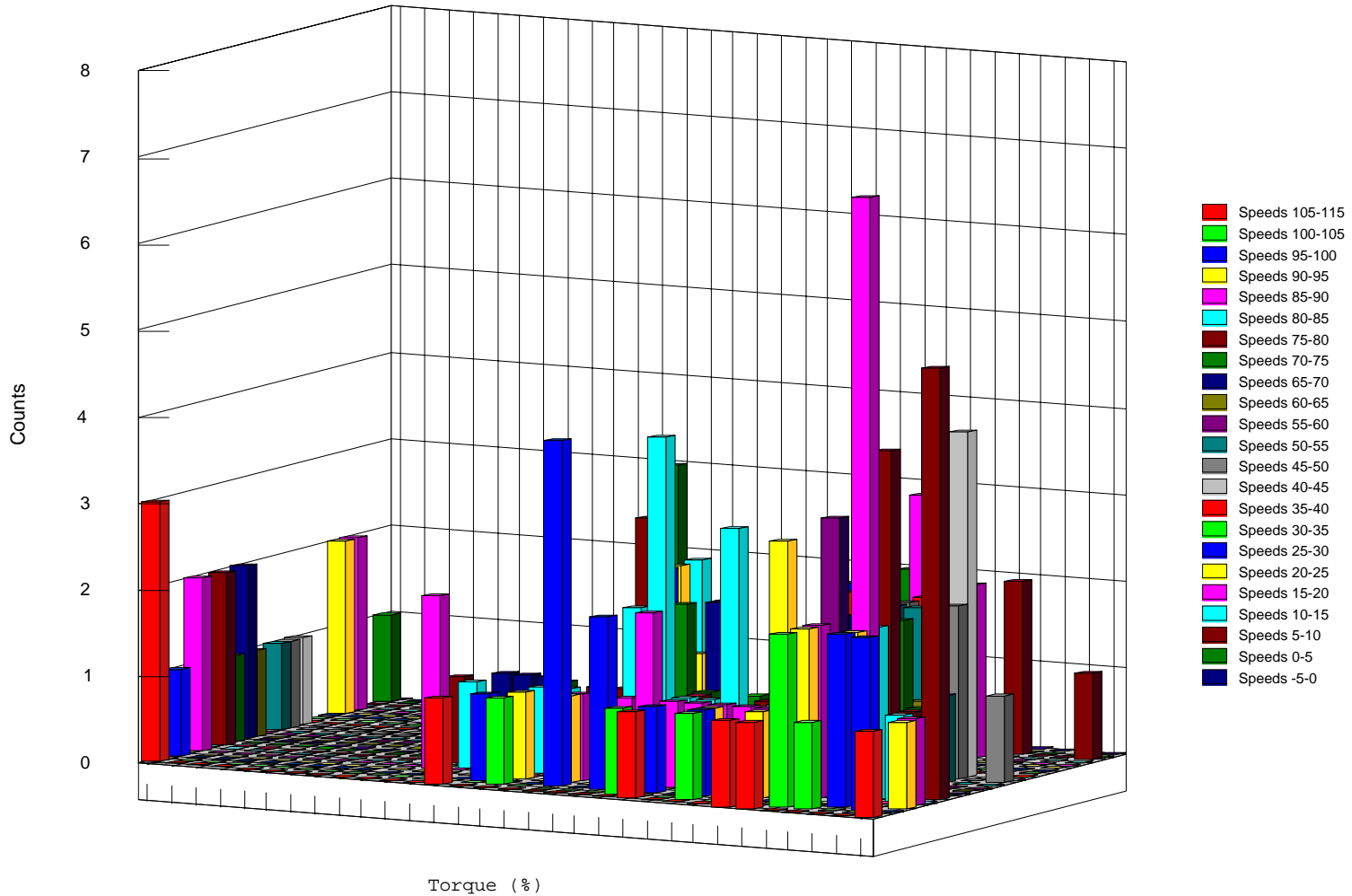
# FTP--Mean Speed Changes



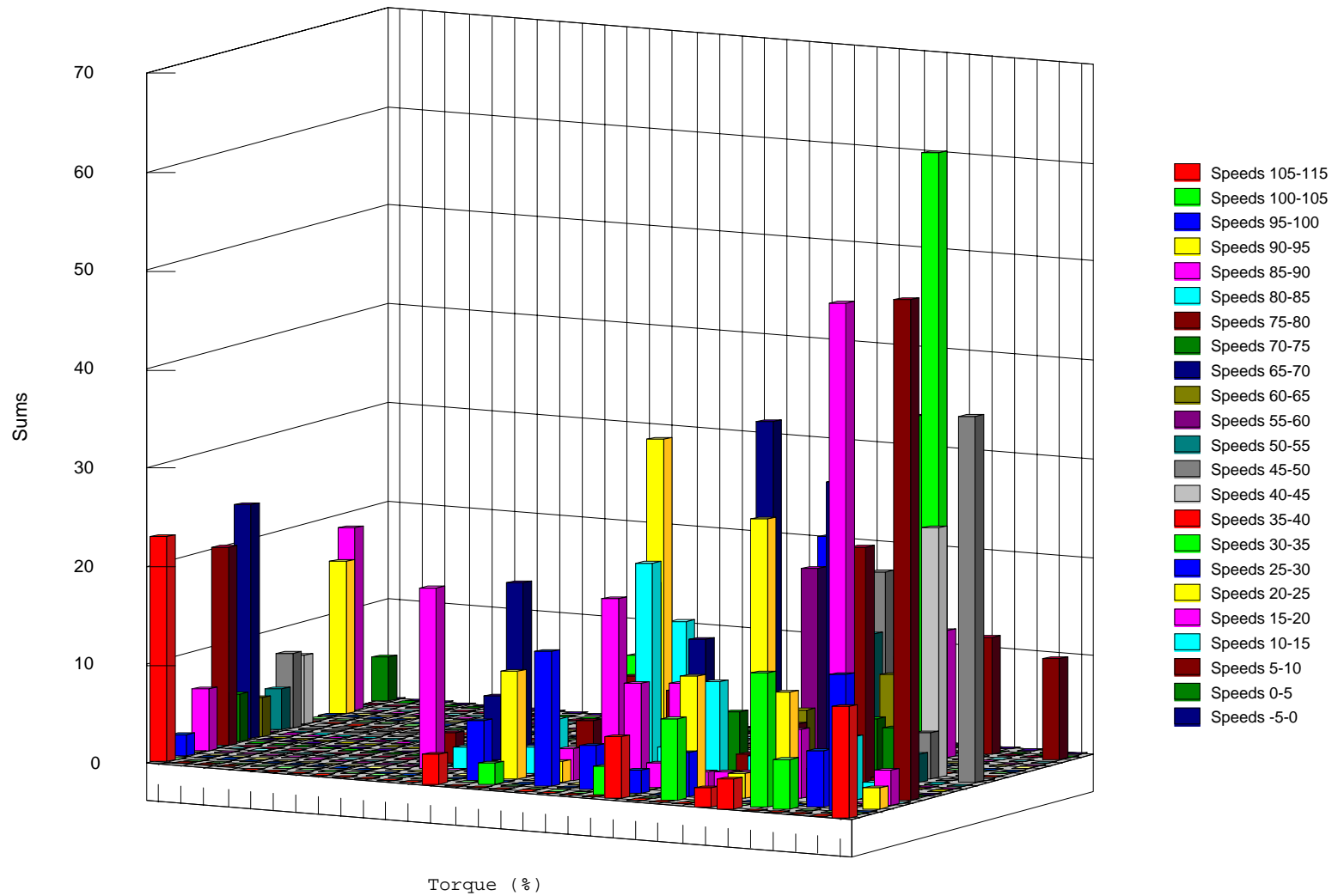
# FTP--Mean Torque Changes



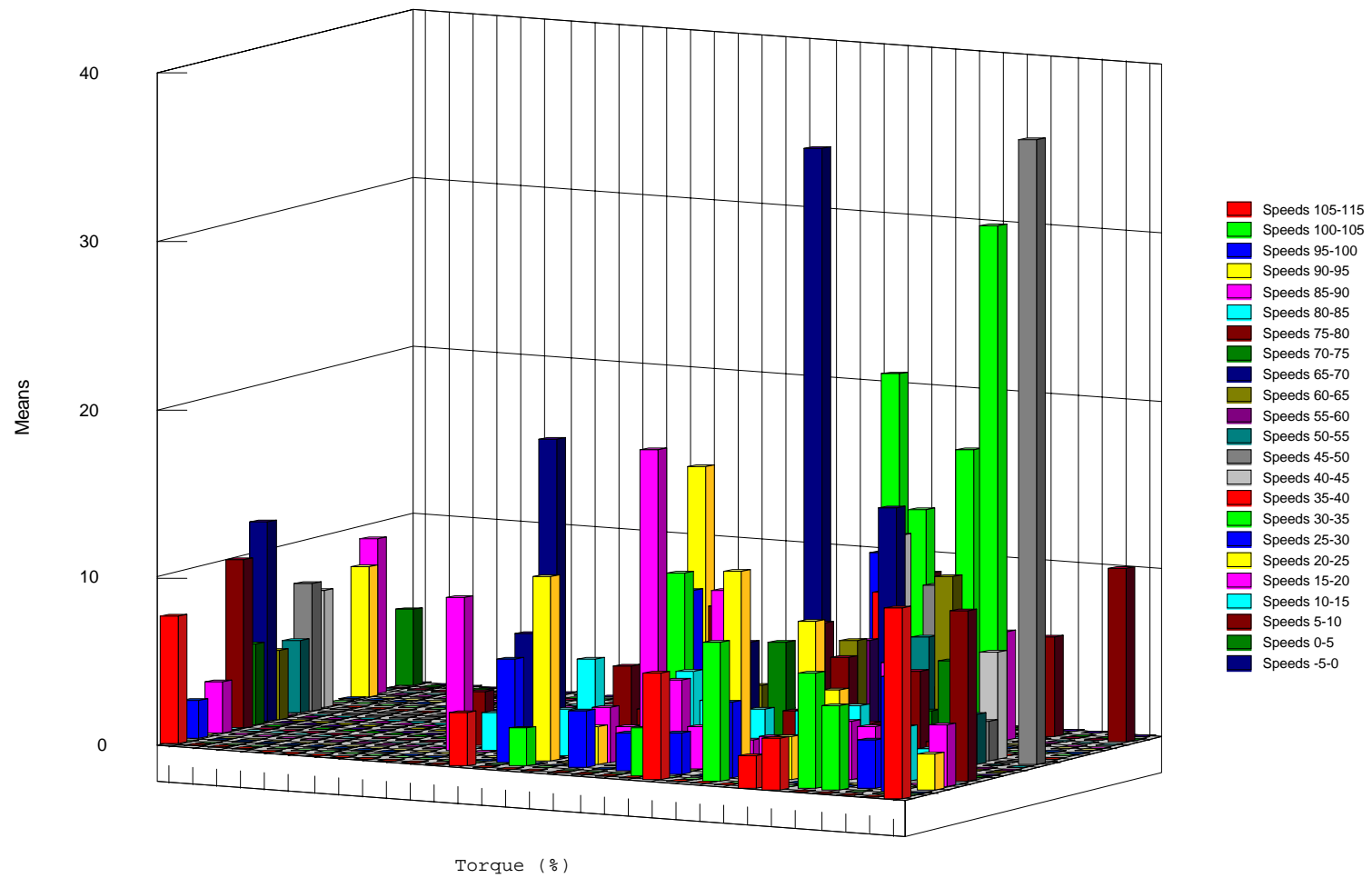
## FTP--Speed Acceleration Counts



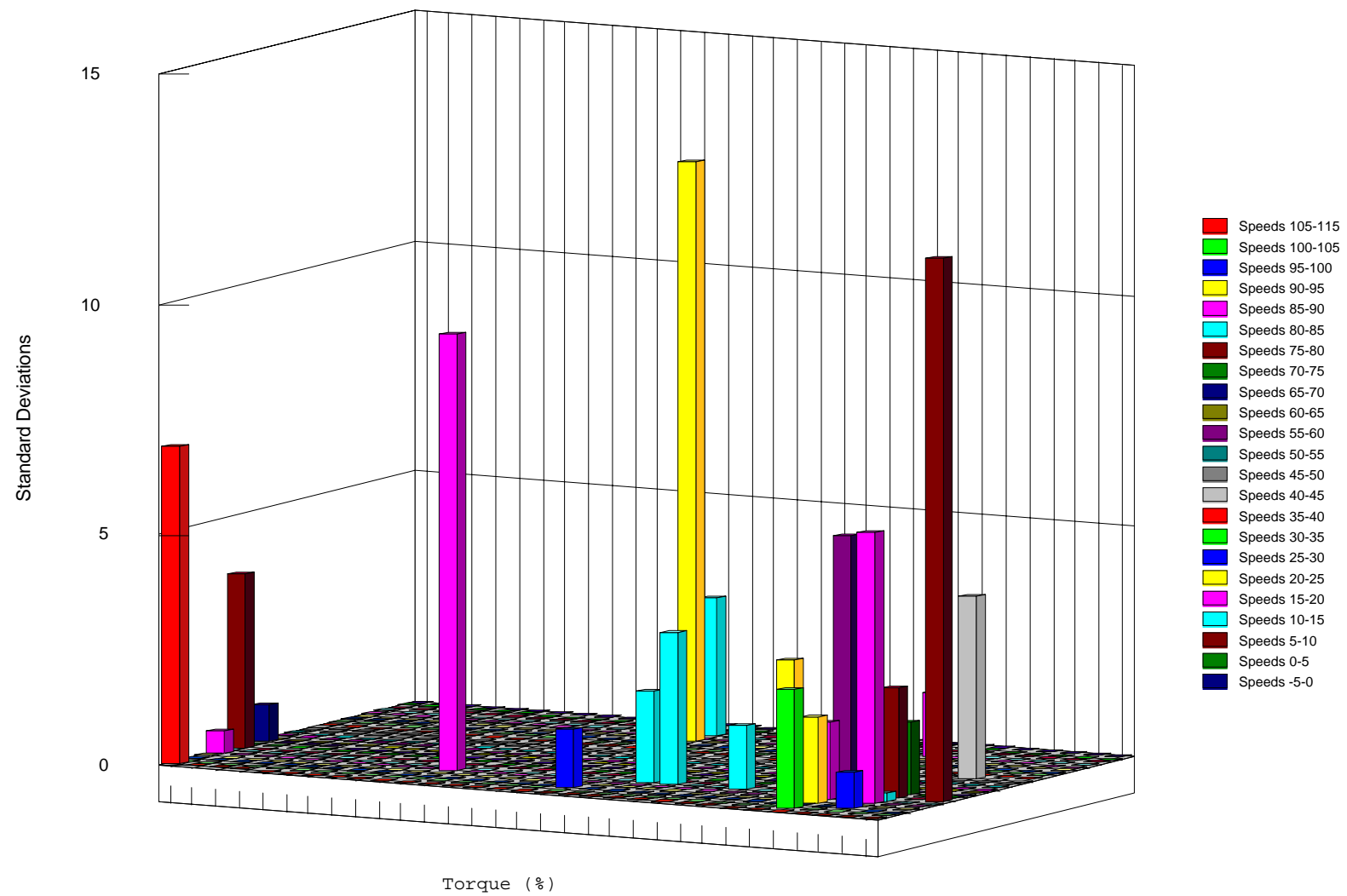
## FTP--Speed Acceleration Sums



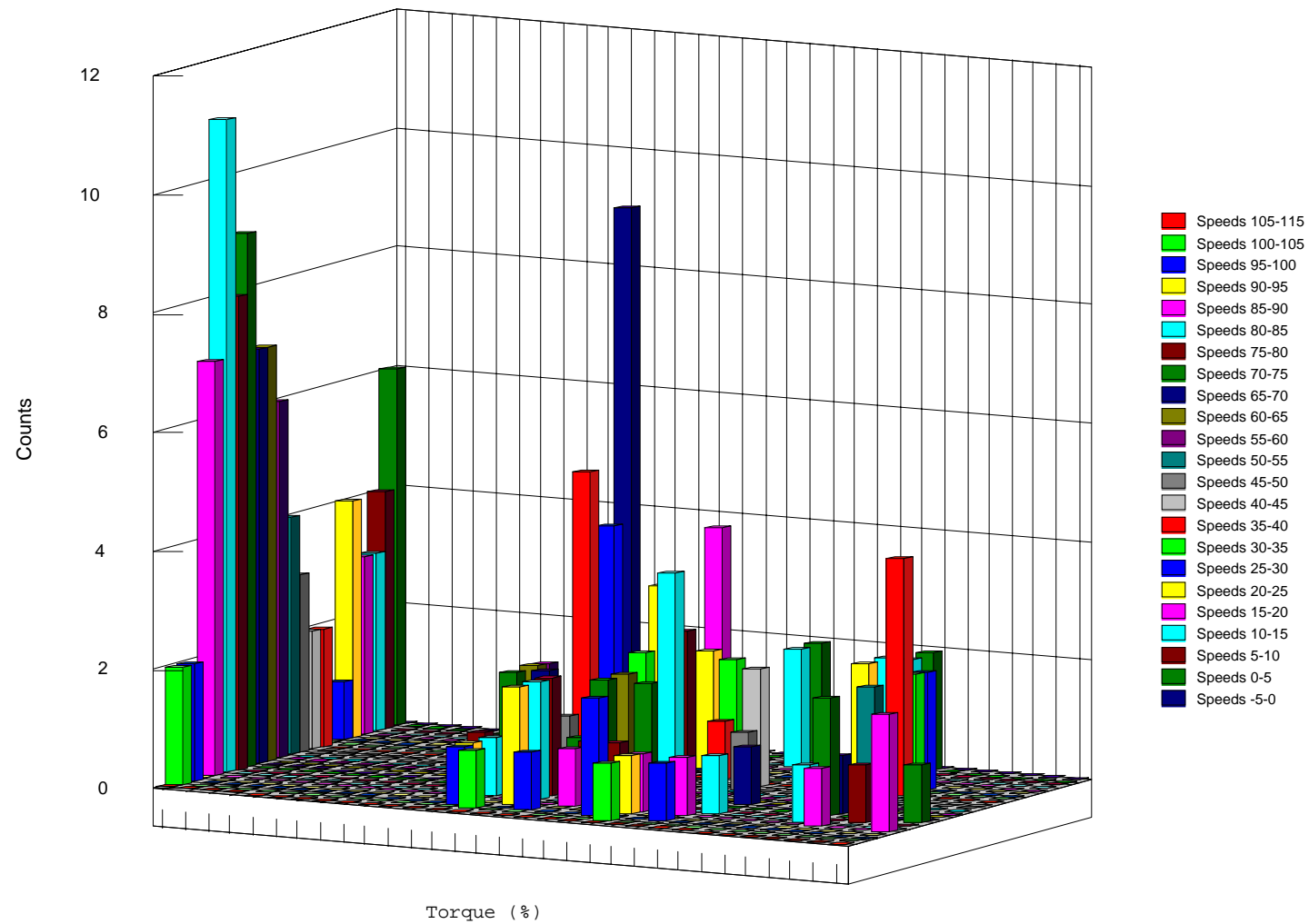
## FTP--Speed Acceleration Means



## FTP--Speed Acceleration Standard Deviations

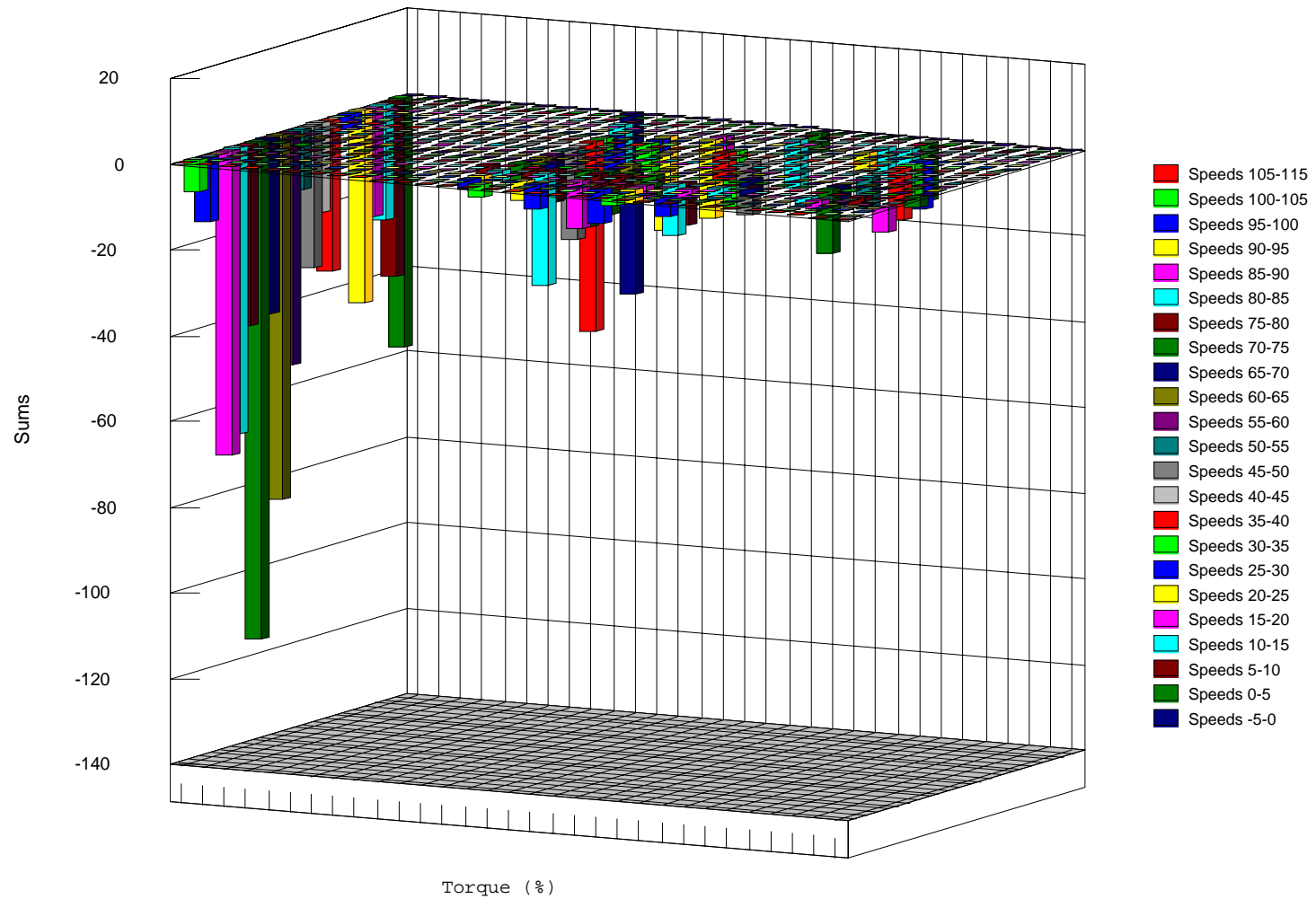


## FTP--Speed Deceleration Counts

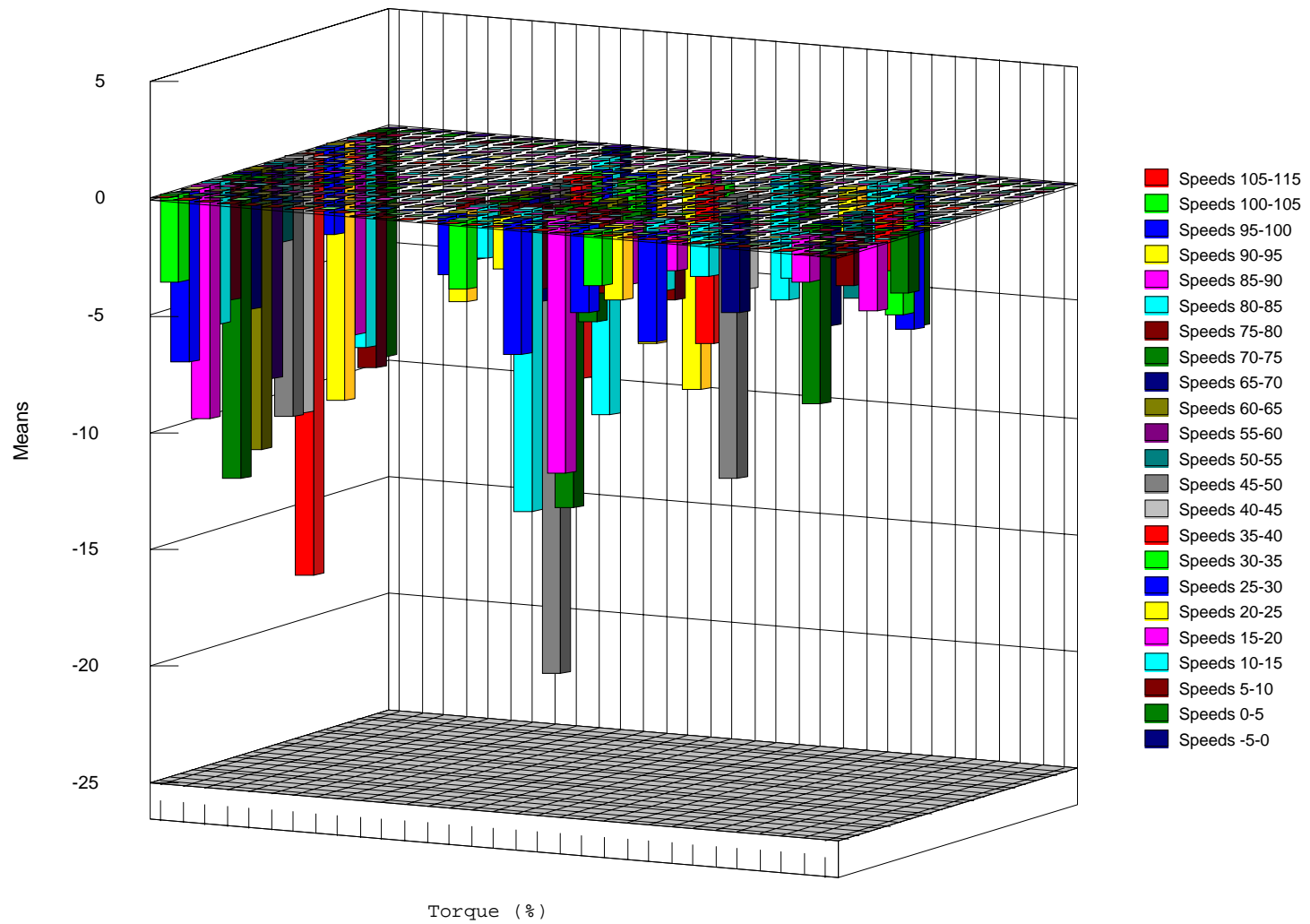




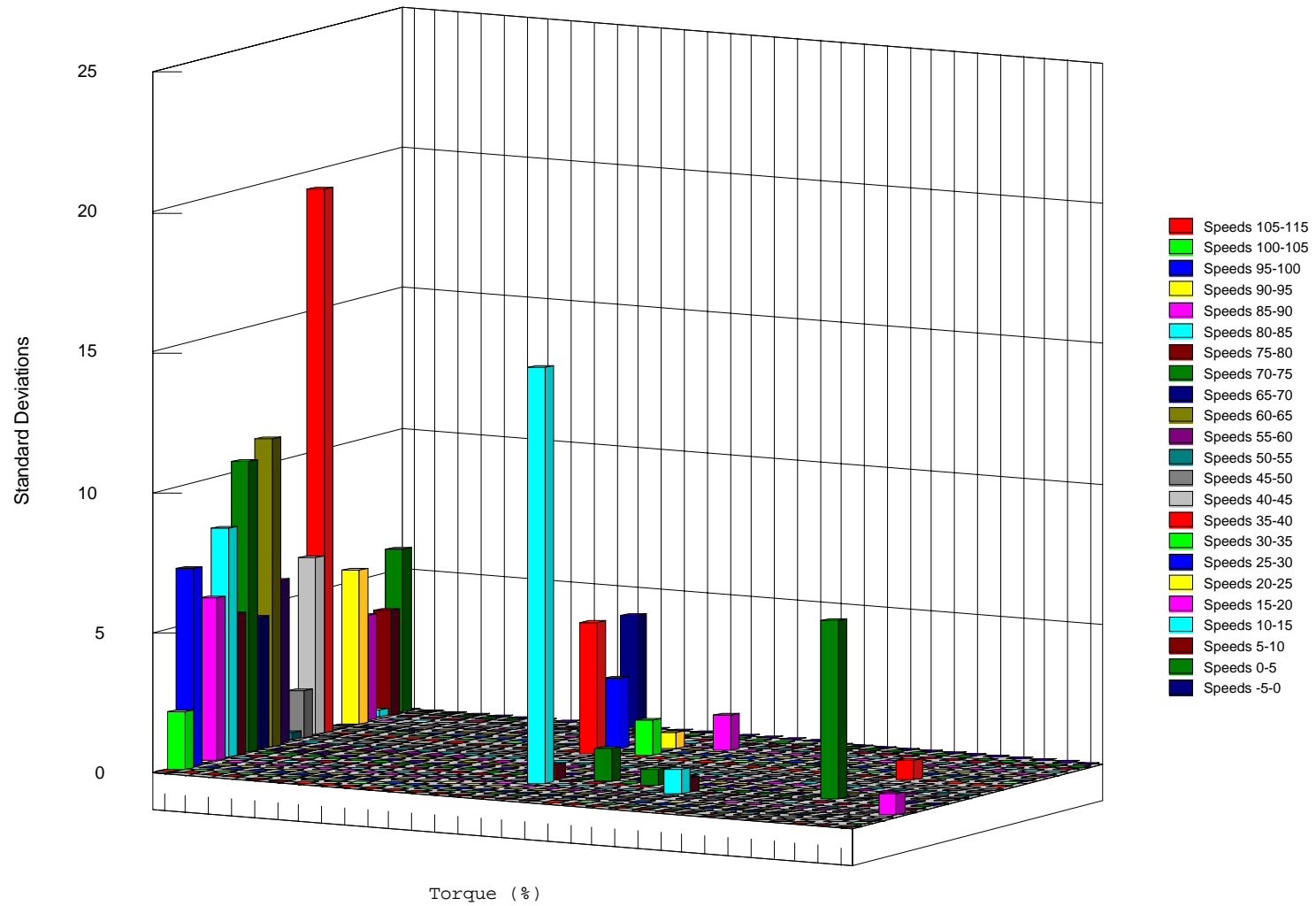
## FTP--Speed Deceleration Sums



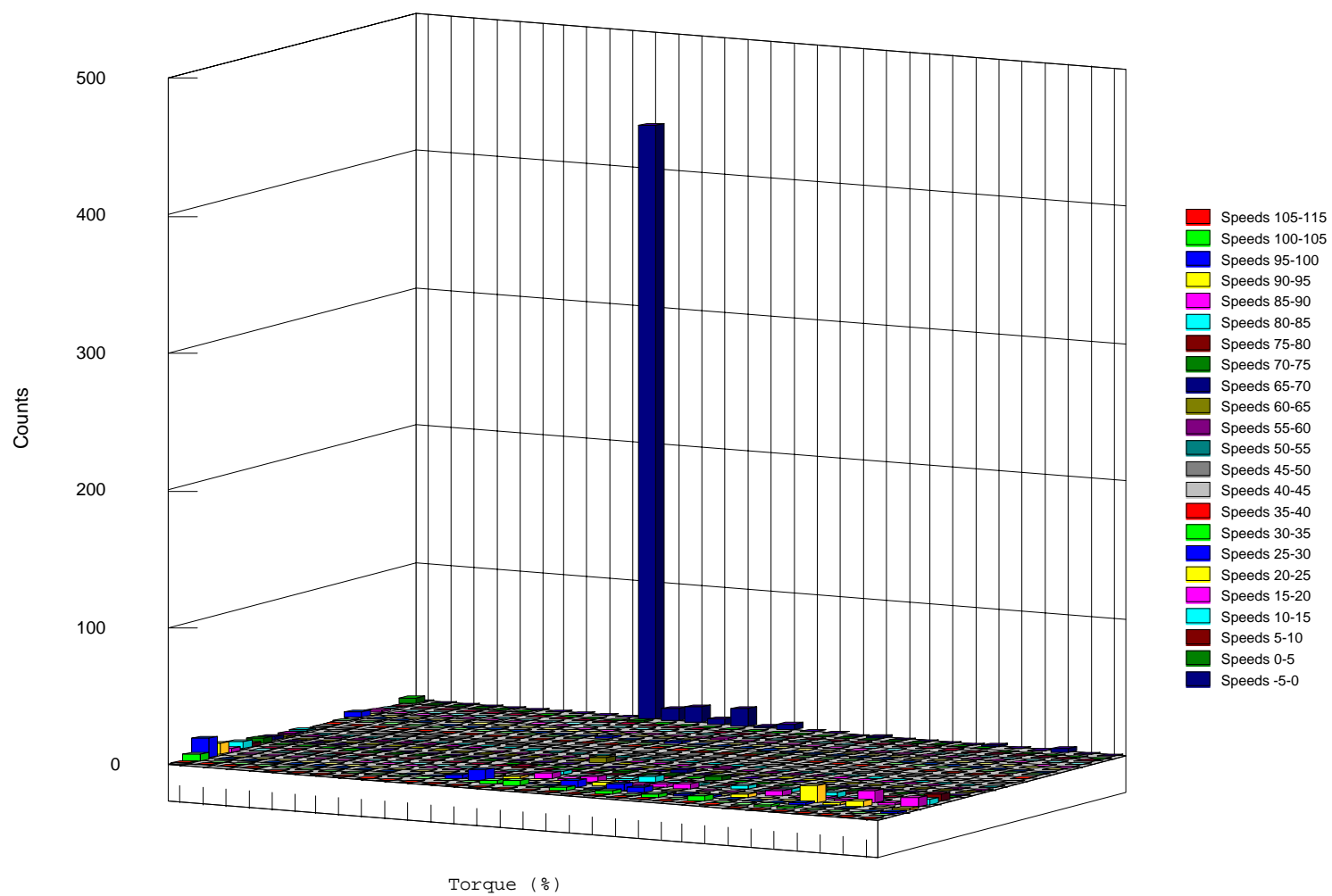
## FTP--Speed Deceleration Means



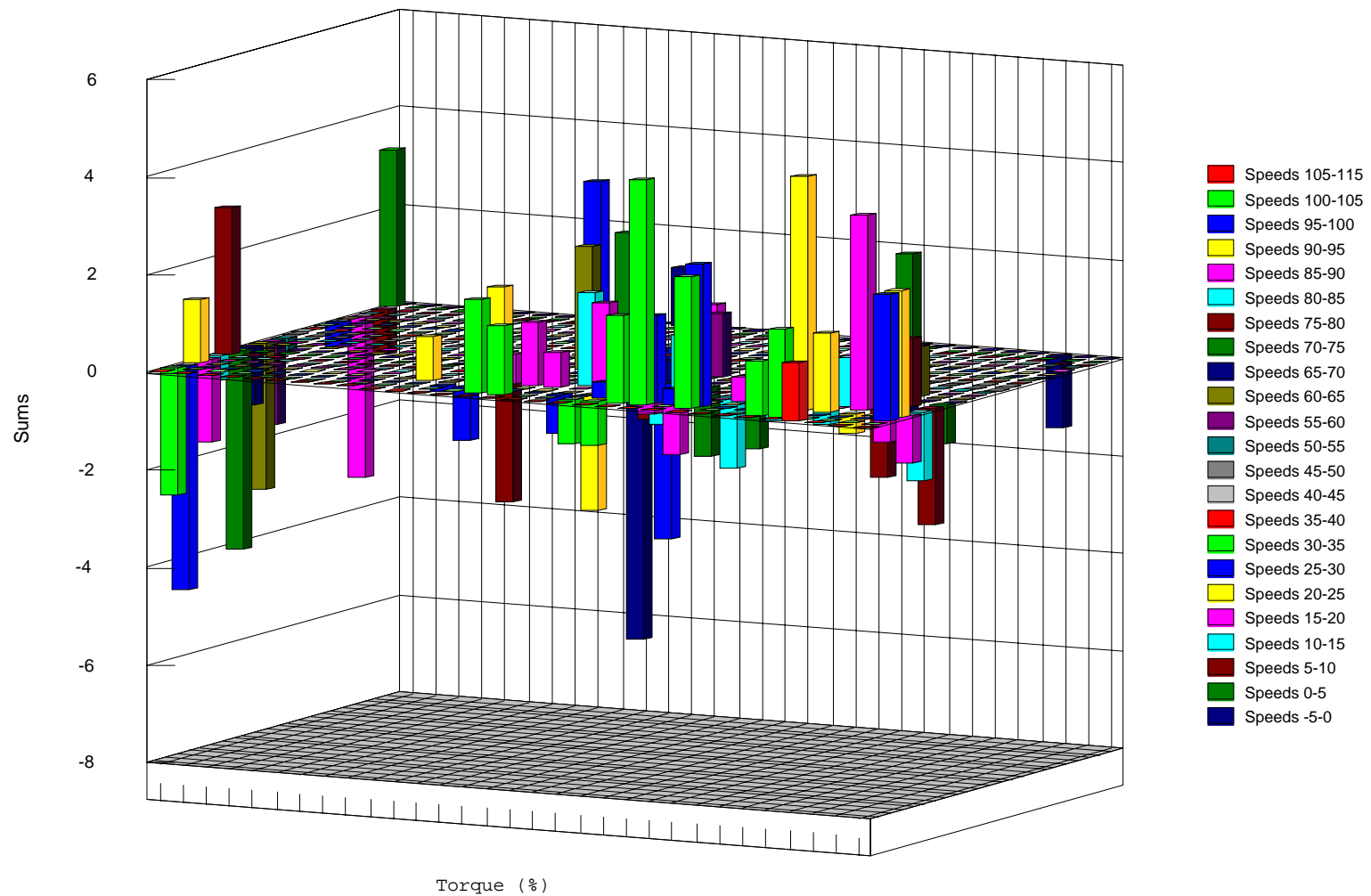
## FTP--Speed Deceleration Standard Deviations



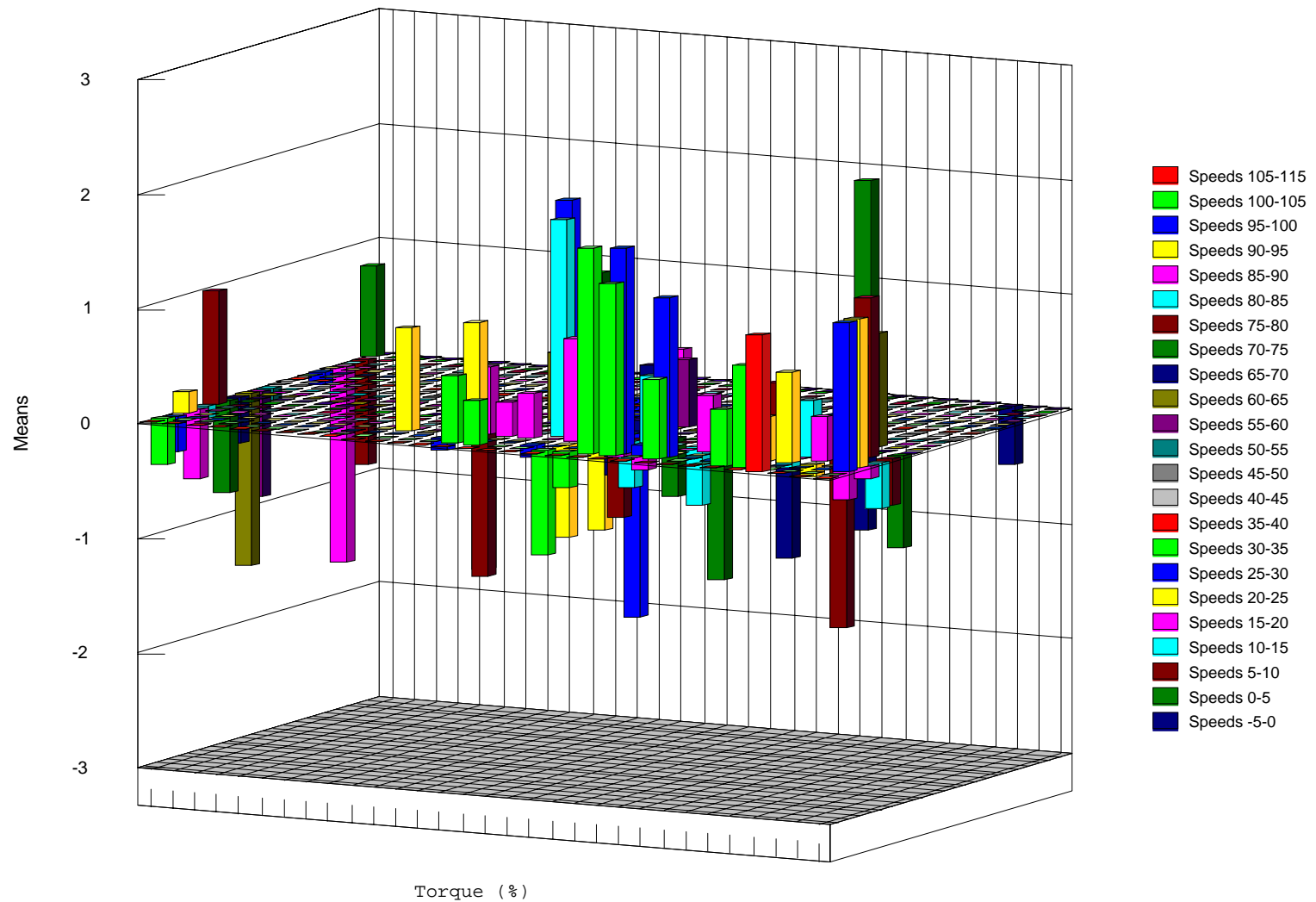
## FTP--Speed Steady State Counts



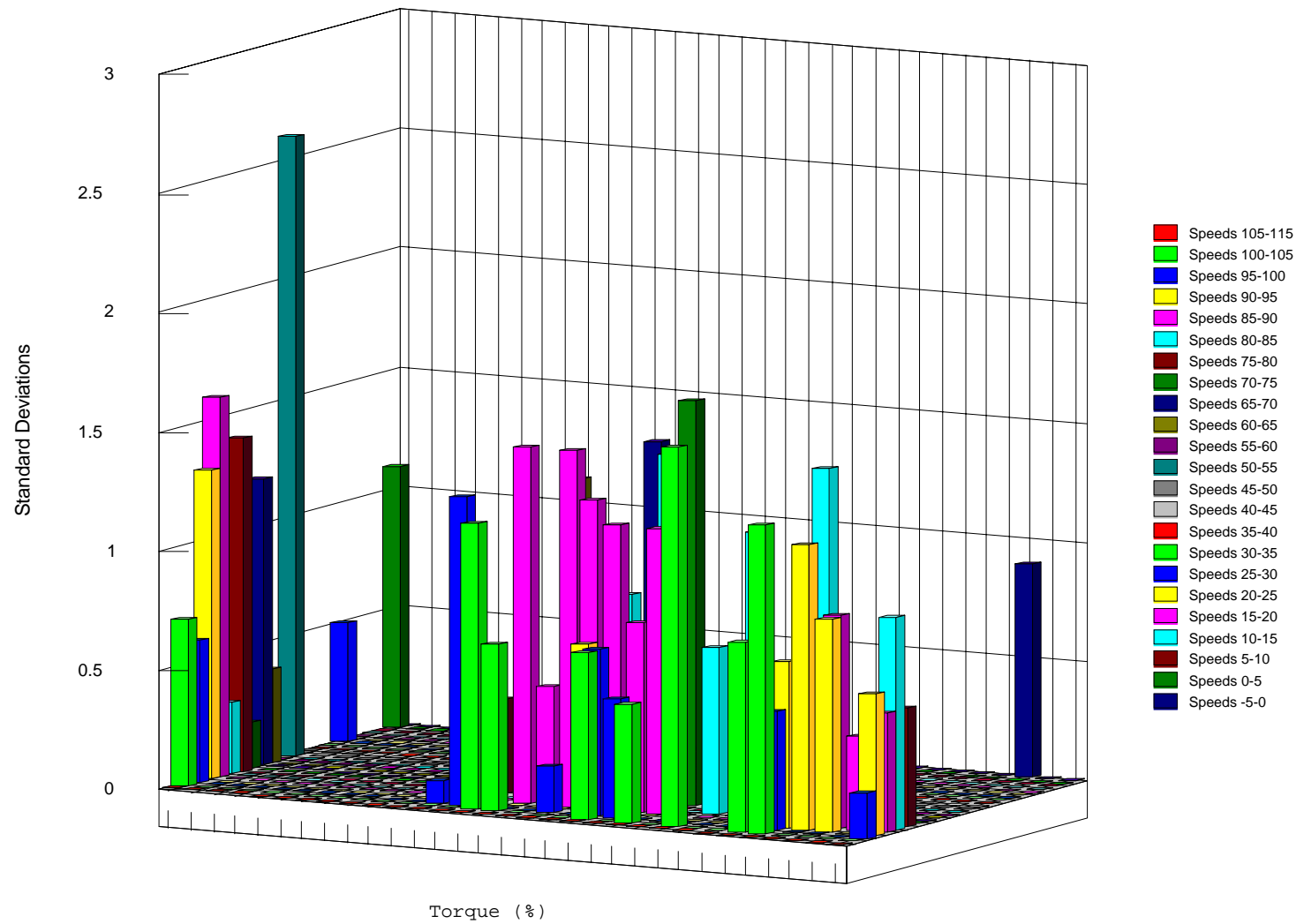
# FTP--Speed Steady State Sums



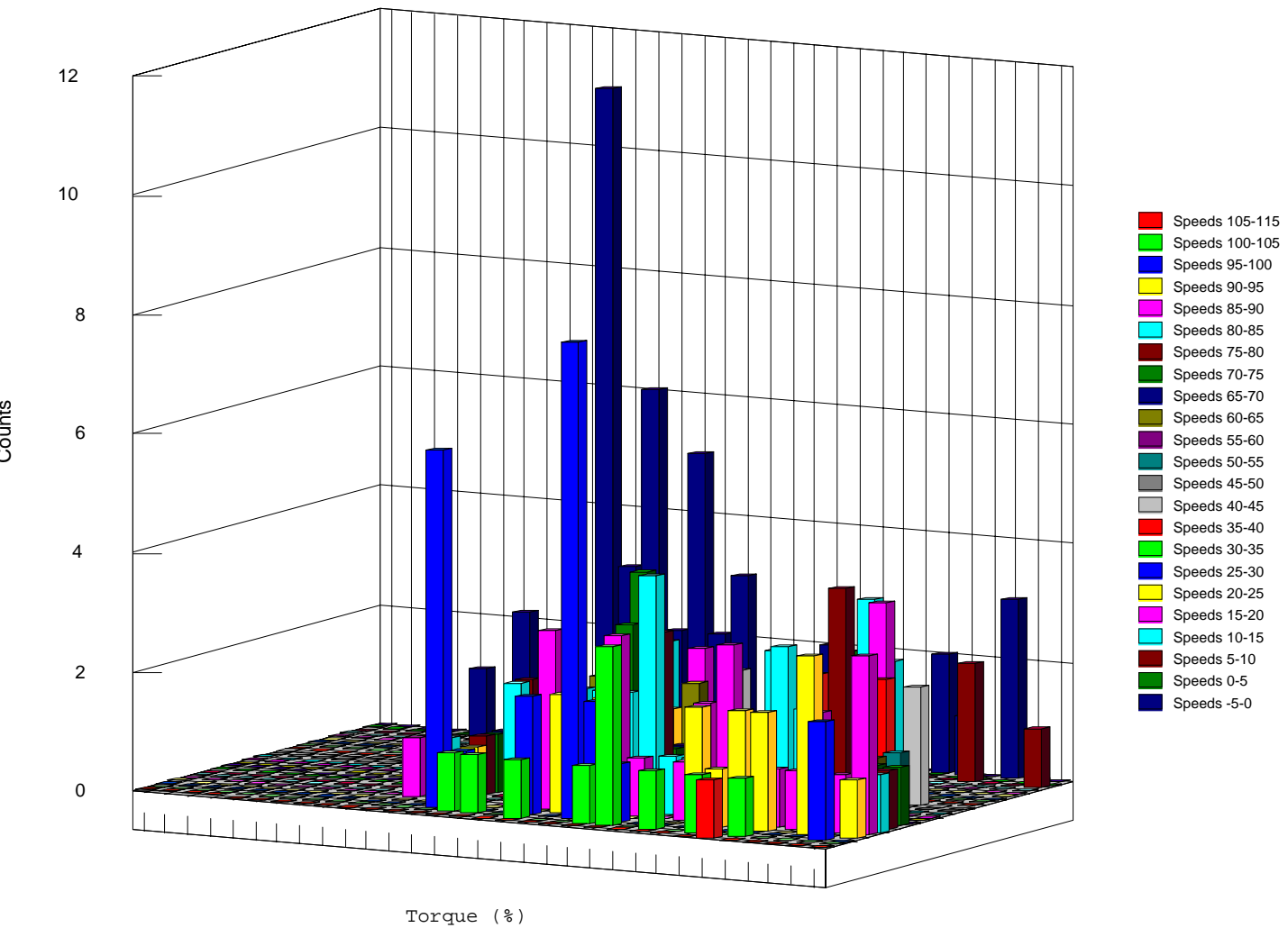
## FTP--Speed Steady State Means



## FTP--Speed Steady State Standard Deviations

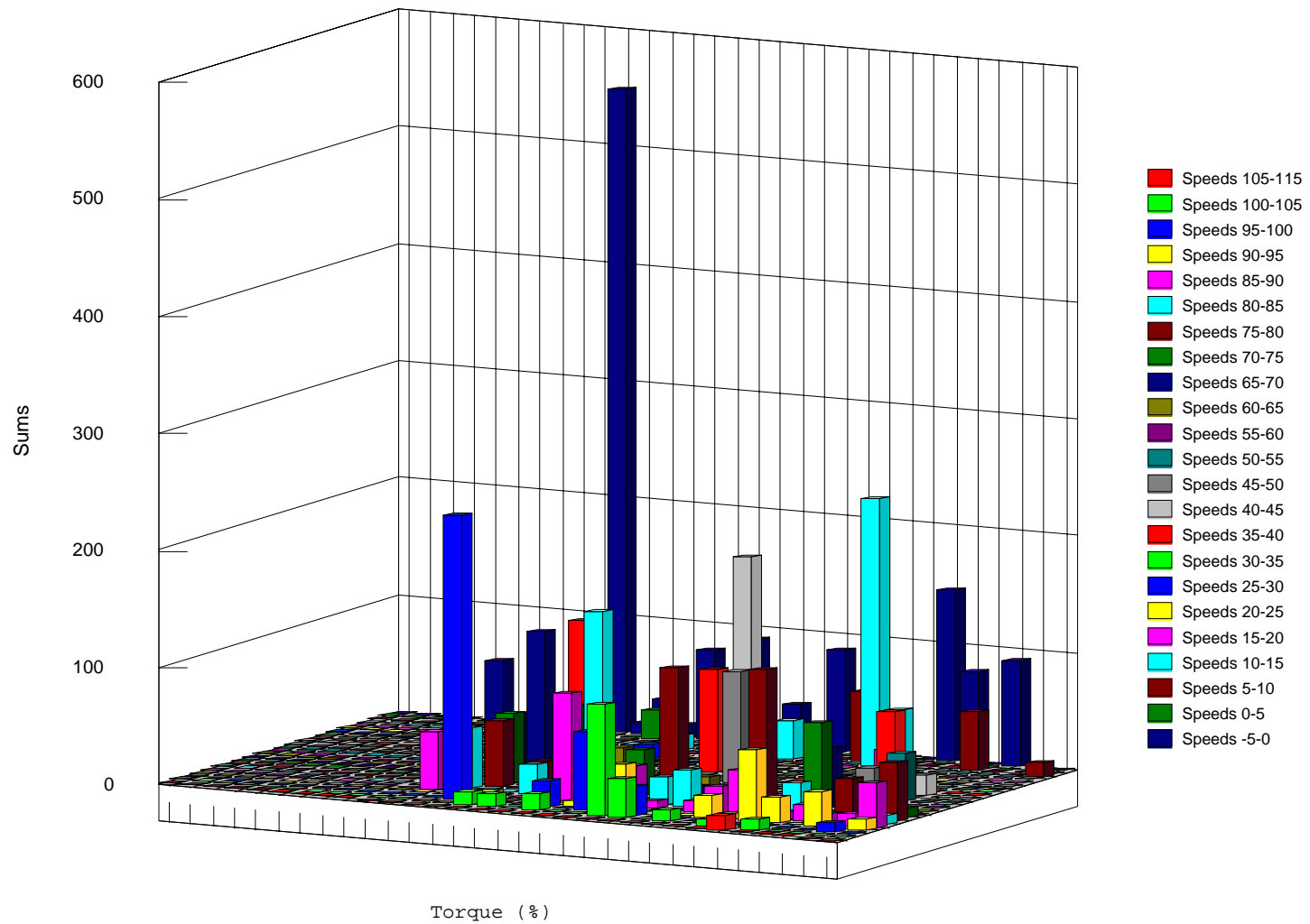


## FTP--Torque Acceleration Counts

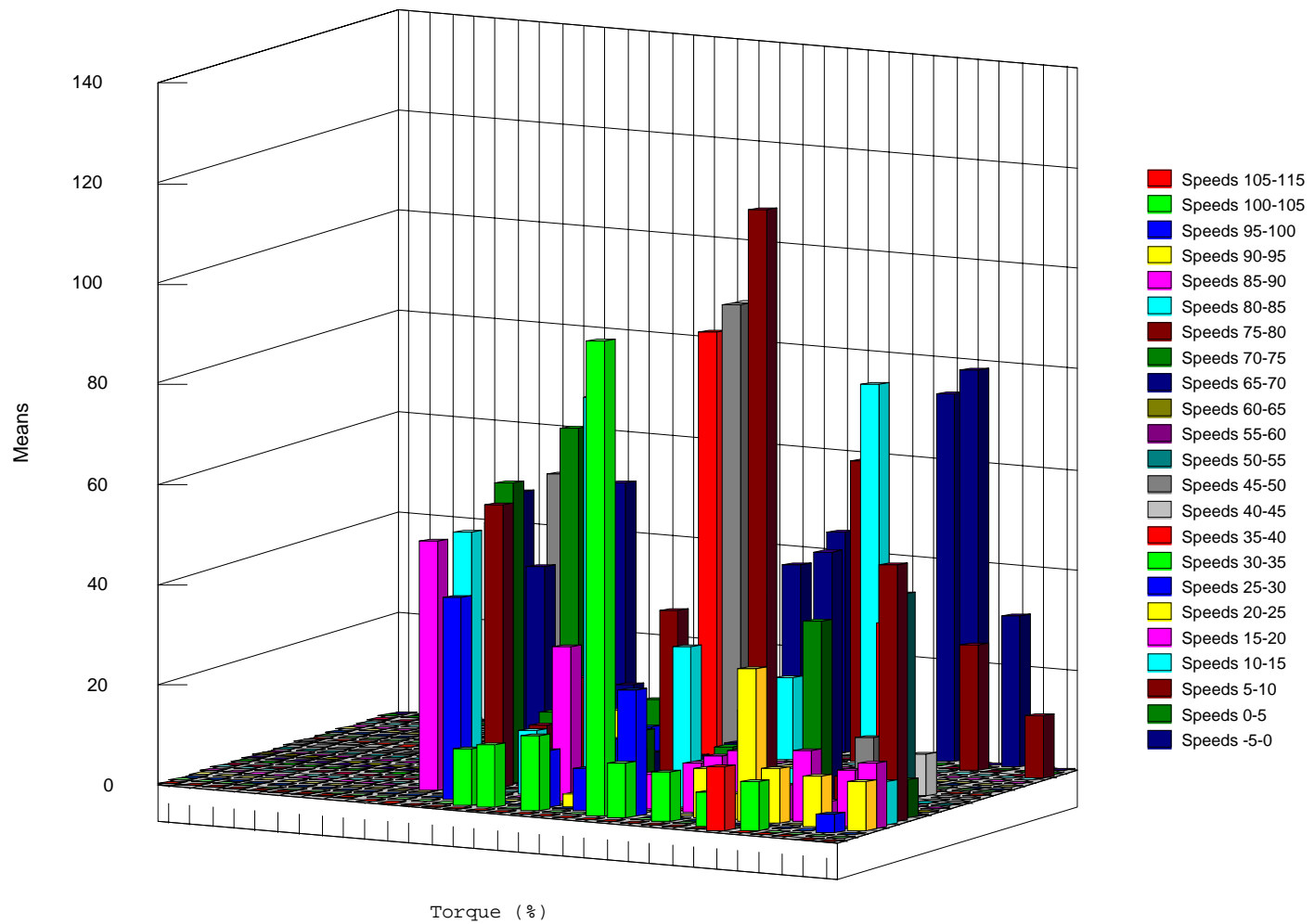




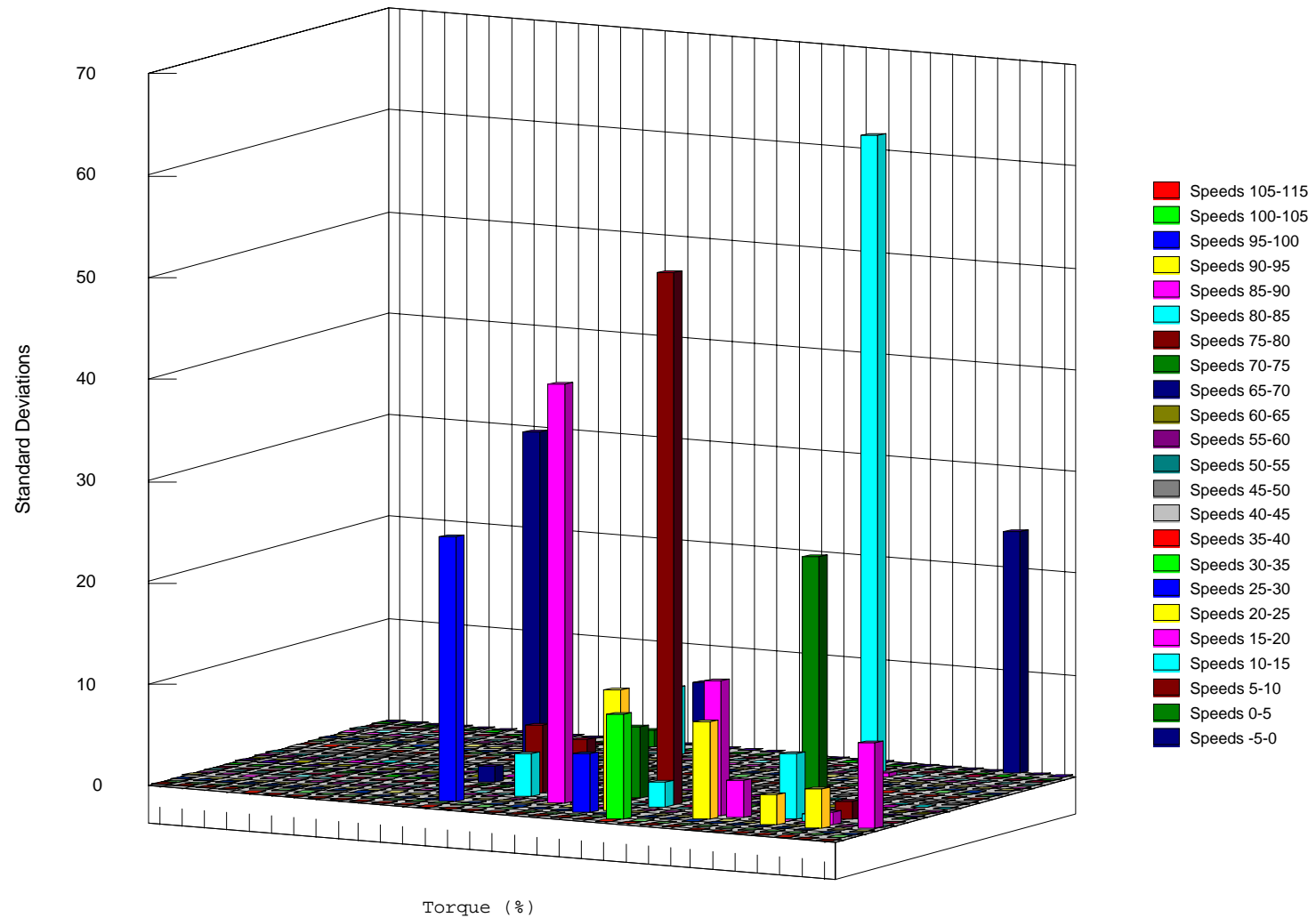
## FTP--Torque Acceleration Sums



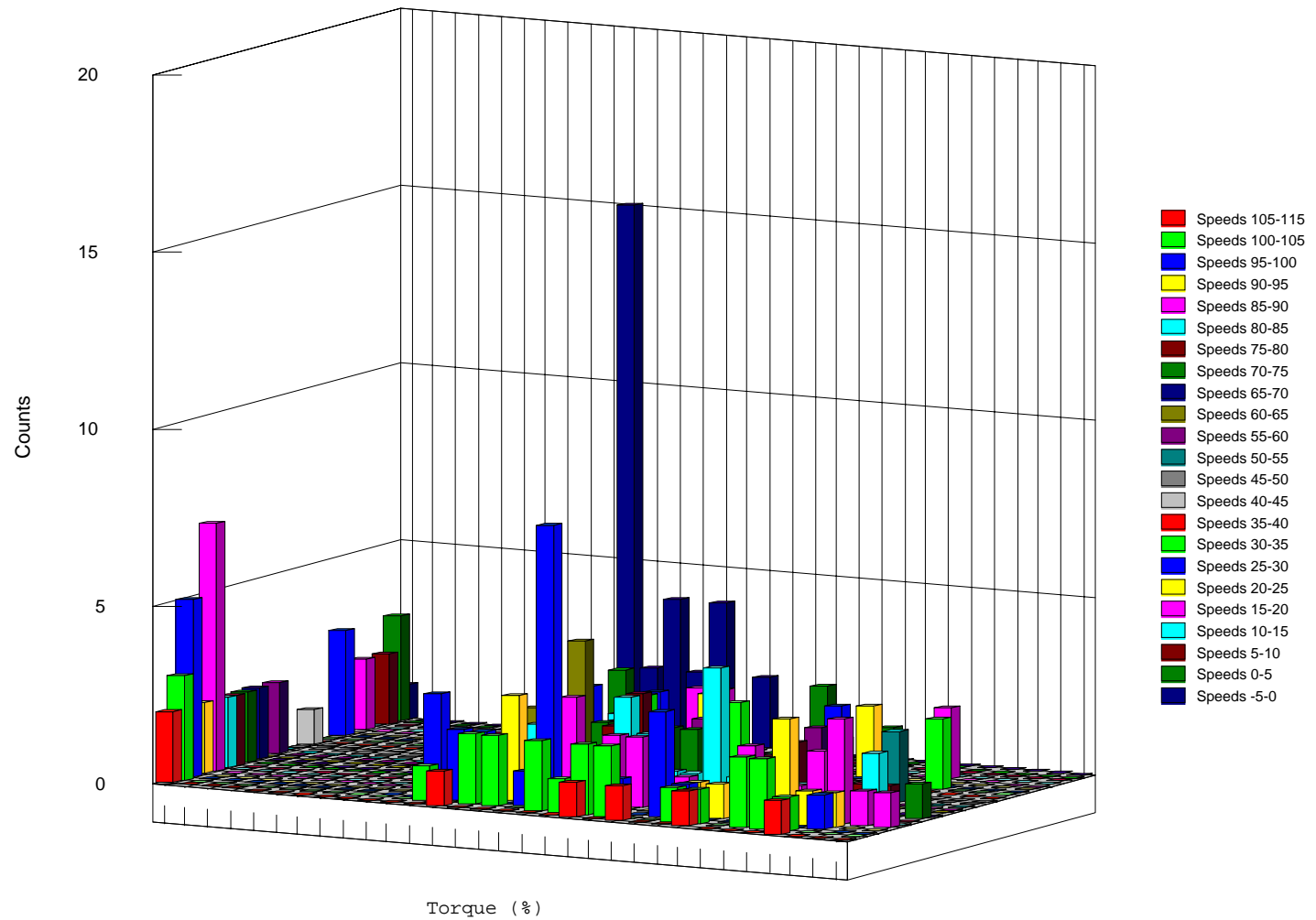
## FTP--Torque Acceleration Means



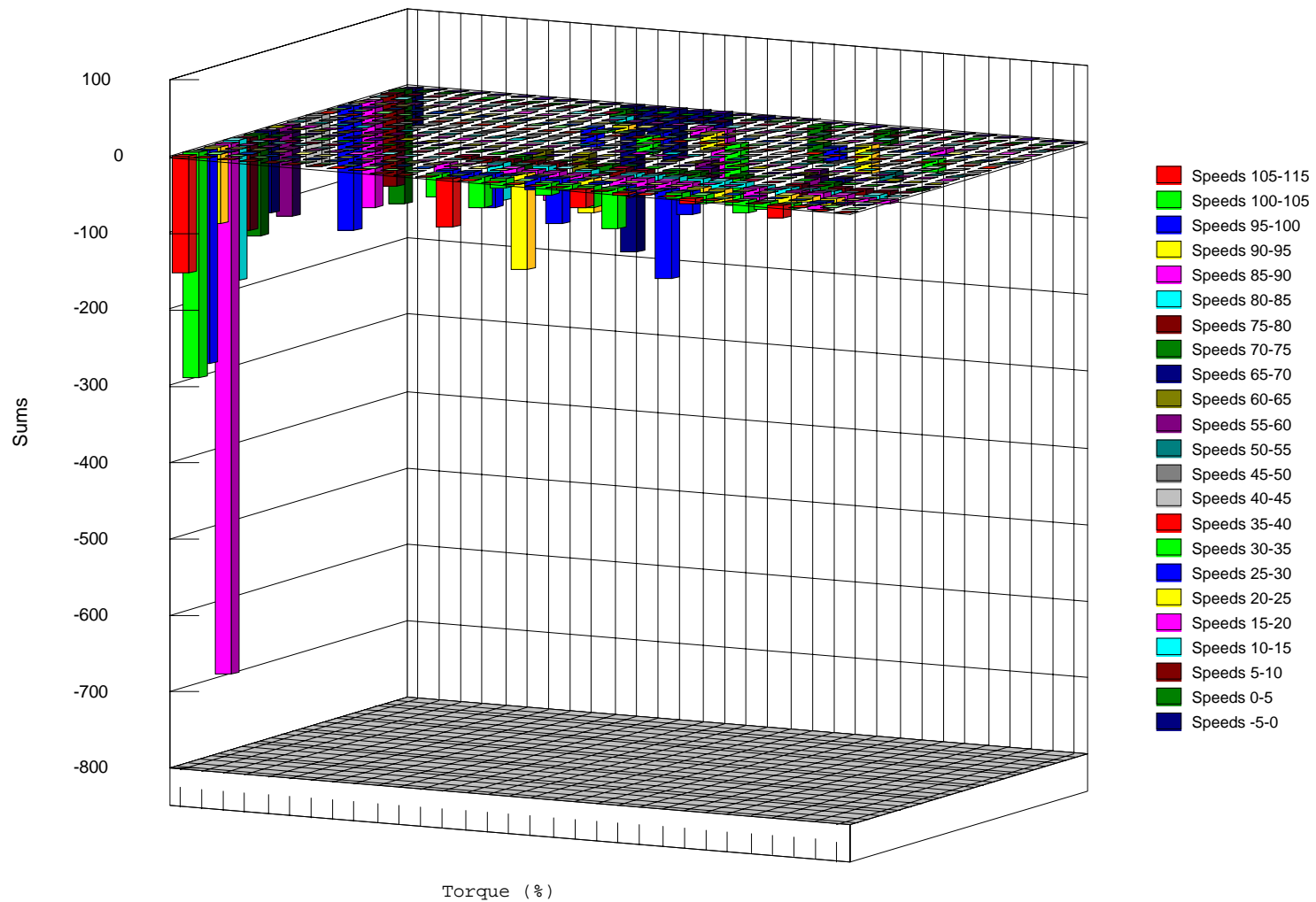
## FTP--Torque Acceleration Standard Deviations



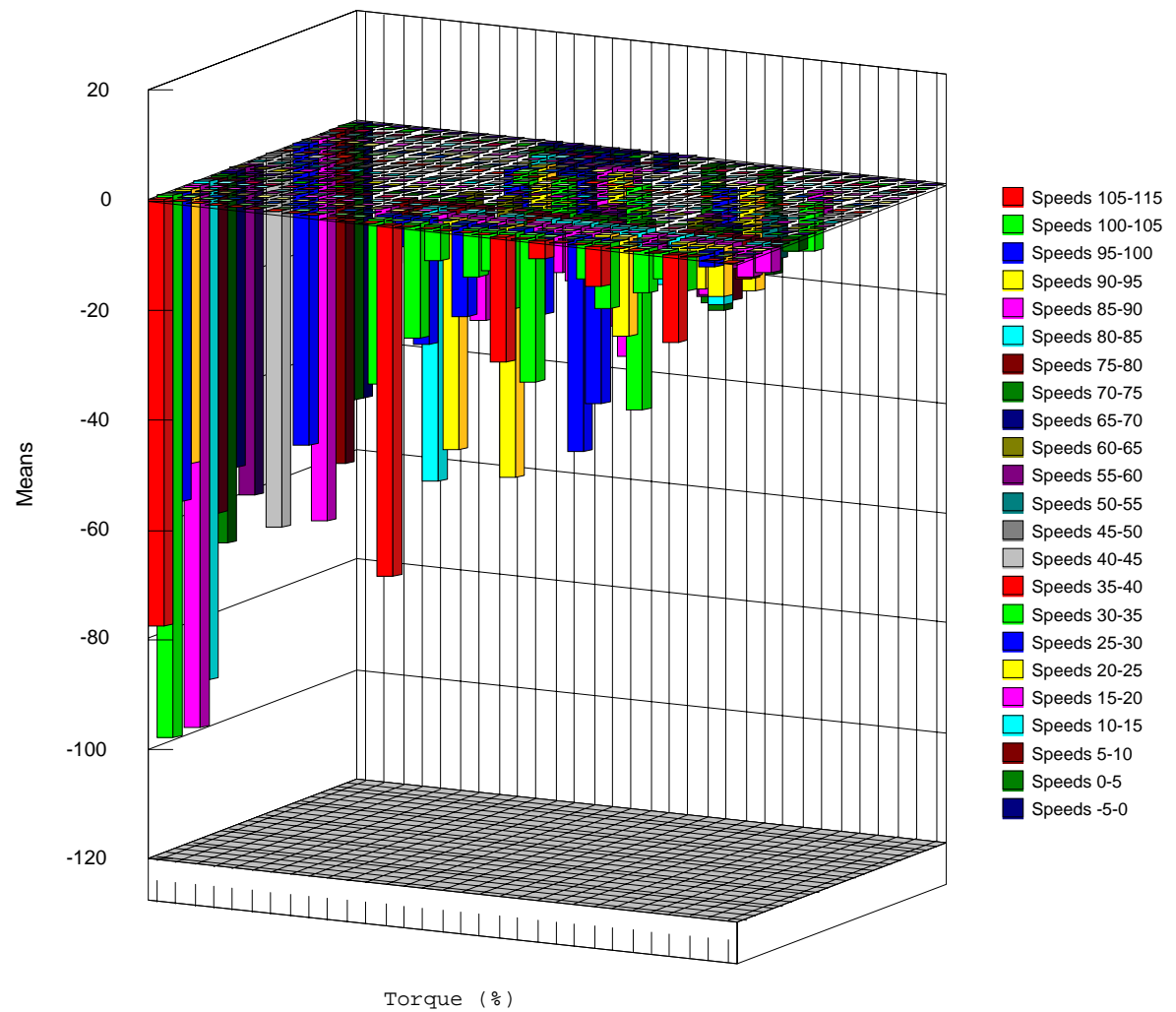
## FTP--Torque Deceleration Counts



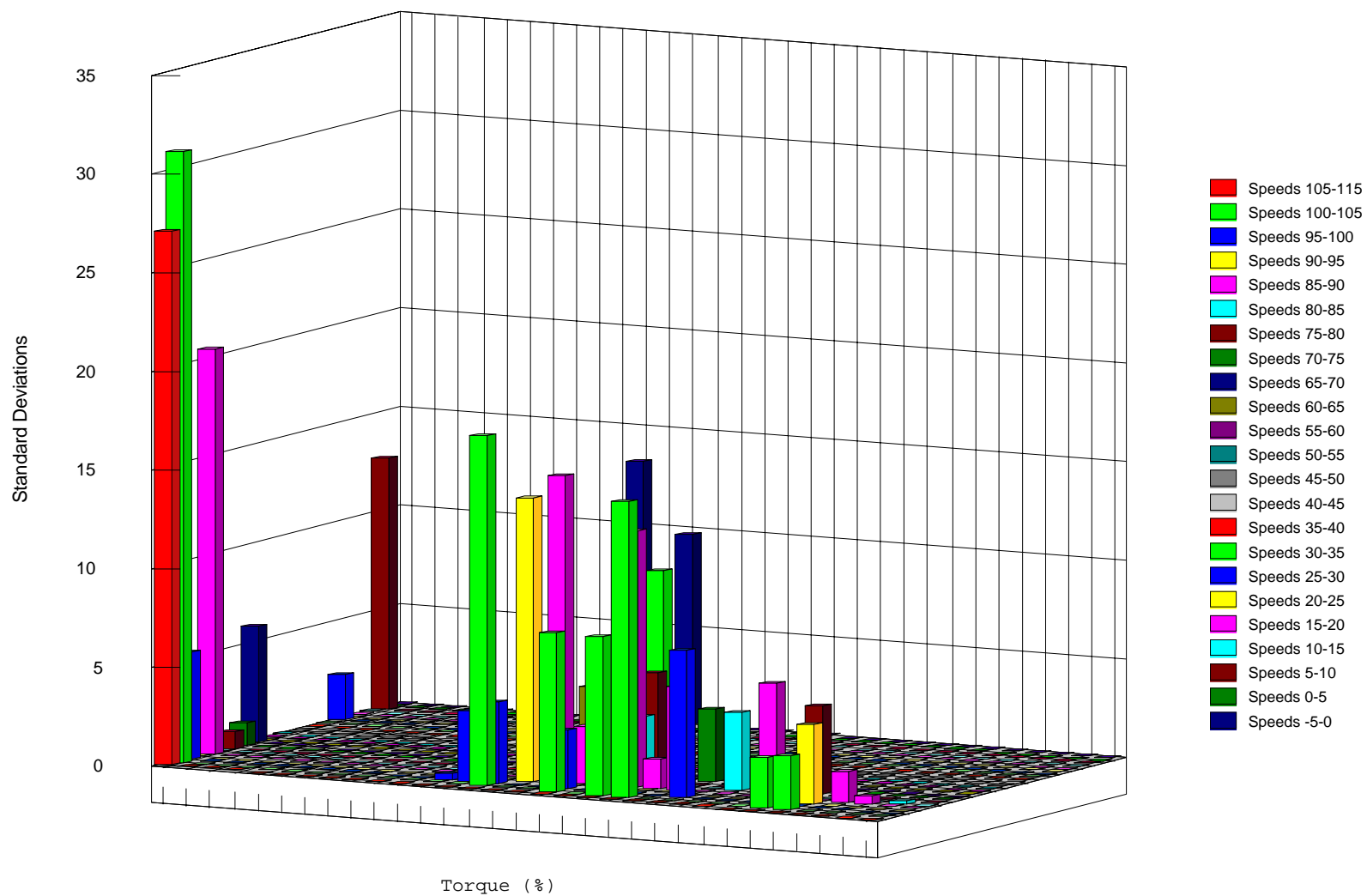
## FTP--Torque Deceleration Sums



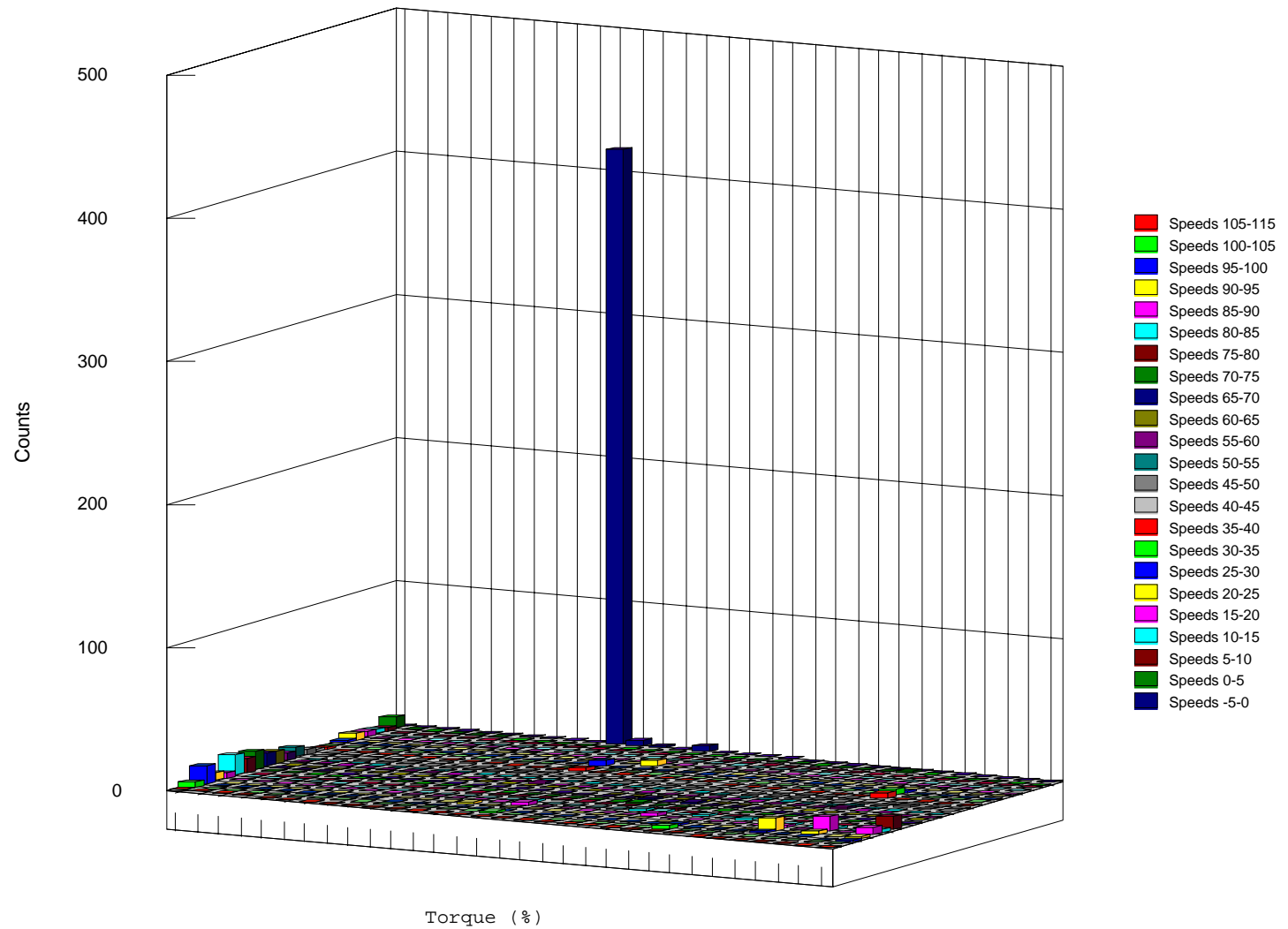
## FTP--Torque Deceleration Means



## FTP--Torque Deceleration Standard Deviations

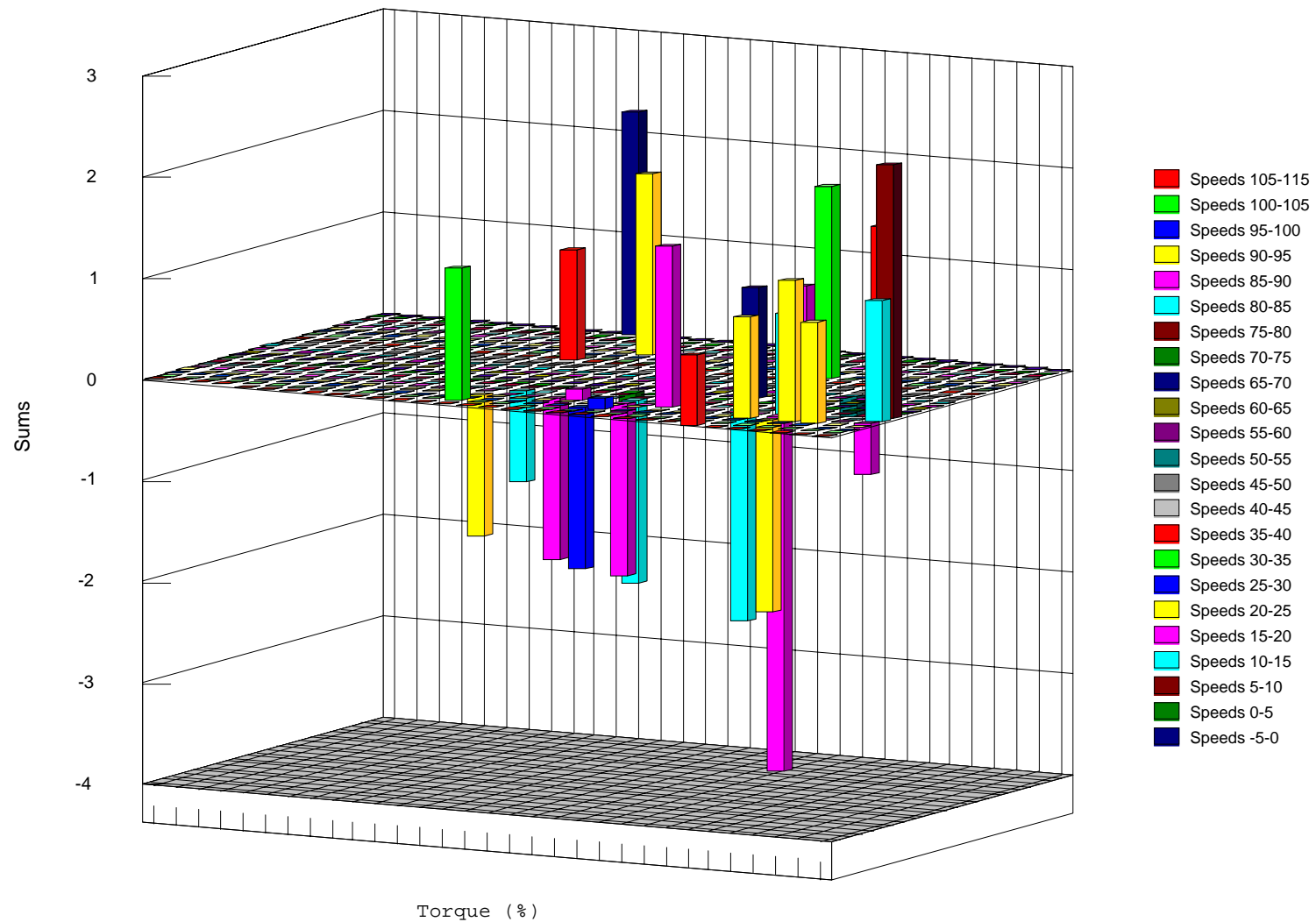


## FTP--Torque Steady State Counts

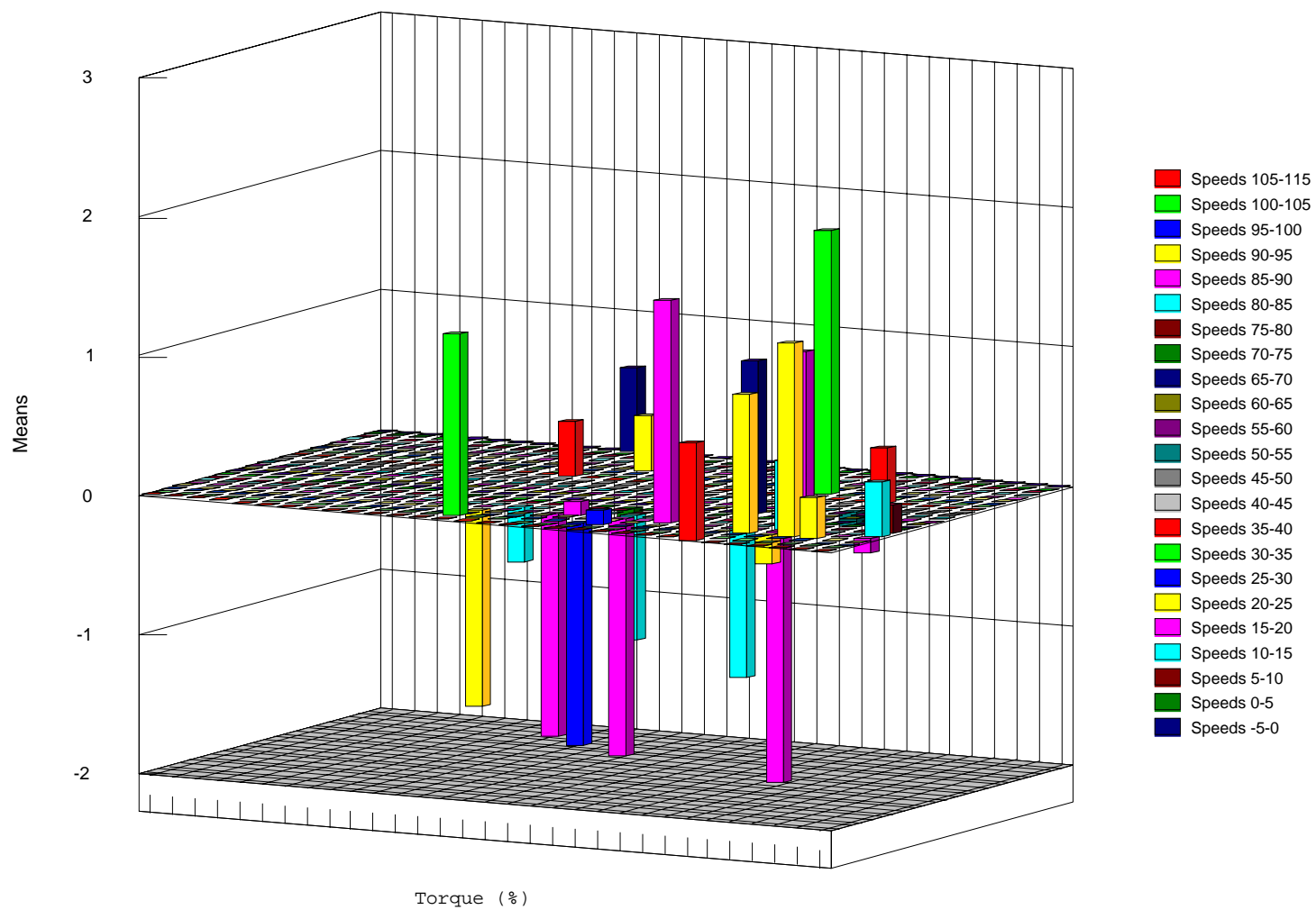




## FTP--Torque Steady State Sums



## FTP--Torque Steady State Means



FTP--Torque Steady State Standard Deviations	
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